OMNI

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JAMES A. MICHENER ON OUR FUTURE IN SPACE · BUILDING A TIME MACHINE · BRAIN WARS · TECH 2000 · MULTISEX SOCIETIES · **EXCLUSIVE:** FIRST LOOK AT SHUTTLE FLIGHT DECK

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OMNI

MAY 1980

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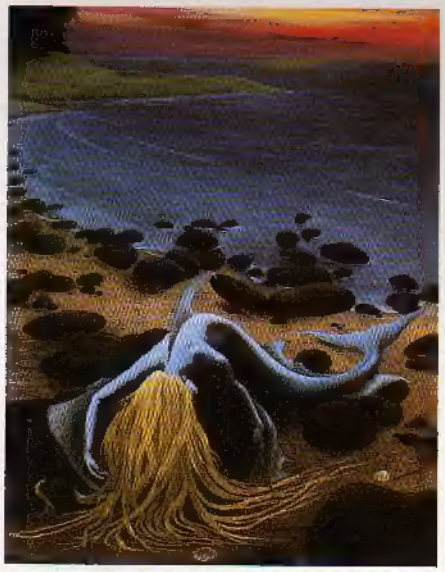

Cover art for this month's Omni is an untitled painting by the French artist Pierre Lacombe. The artist, who wanted to paint since age fifteen, began only ten years ago, at age thirty-eight. He now resides outside Paris.

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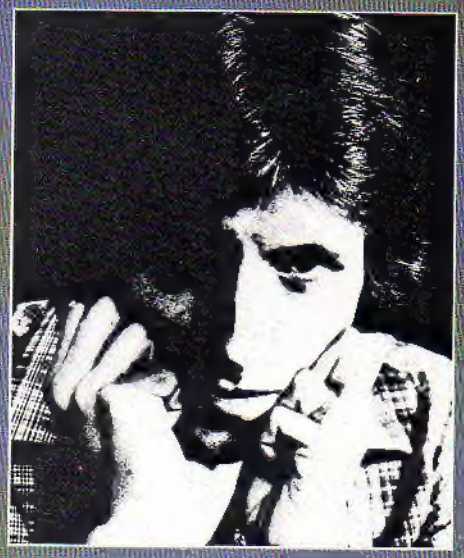

STAN KENT

Space enthusiasts can demonstrate their support for NASA this election year by donating to the Viking Fund and continuing the exploration of Mars.

Mars has intrigued us since the first astronomers gazed upward at its canals and red sands. Our fascination has never waned, and, if anything, the Viking landings in 1976 only increased our interest. NASA reports that more than 17,000 letters were received following the landing and that public interest remains high four years later.

The spacecraft are still on Mars, with *Viking 1* sending back weekly bursts of data automatically until at least 1990. Important weather patterns are emerging on Mars that will help us plan for our eventual return to the Red Planet.

Although NASA provides the funds for processing *Viking*'s data, a problem still exists. Once the information has been collected and stored in computers, there may not be enough money left to evaluate it. Even if funds should become available, inflation will compound the need for additional operating expenses. Radio telescopes must continue to receive the data essential to future experiments on the Martian surface.

All space enthusiasts realize that this is an election year. Much has been said about the size and spirit of the pro-space constituency, but it has yet to manifest itself in a forceful manner. What better way to demonstrate support than by actually funding a space project through donations?

Carl Sagan has suggested in his book *The Cosmic Connection* that unmanned exploration could be funded by private donations. It is time to do just that. The San Francisco section of the American Astronautical Society at the suggestion of Eric Burgess, long-time space researcher and reporter, has established a fund — aptly christened the Viking Fund — for this purpose. The goal is to raise $1 million specifically for Viking activities by July 20, 1980.

NASA, as a federal agency, cannot and does not endorse the fund. The agency has indicated an active interest in the fund, however, and in conversations with the organizers has promised — to the best of its ability — to channel the monies collected toward Viking's operations.

All contributions will be placed into a trust fund and be distributed to NASA on a year-to-year, item-by-item basis, much as Congress allocates money to the space agency (although the Viking Fund will not depend on congressional budget review and the attendant budget hacking so familiar to all of us). Moreover, NASA, the Jet Propulsion Laboratory [Viking Mission Control Center], and the fund will cooperate in jointly supporting Viking activities, such as operating the radio telescopes of the Deep Space Network or analyzing data and photograph enhancement. The fund could also support aerospace studies at research institutions or universities.

All contributors will receive an acknowledgment of their tax-deductible gift, and the fund will endeavor to keep contributors informed of both *Viking*'s and the fund's progress. Administrative expenses of the fund are kept to a minimum because all fund helpers are volunteers. Students and space enthusiasts are willing to work long hours without pay for the advancement of space exploration.

If successful, the fund will do more than merely collect and analyze scientific data. It will set an important precedent for joint private/government funding of space research. NASA's charter legalizes the agency's ability to accept donations. The Viking Fund goes one step further by establishing a nongovernment mechanism for space projects that could eventually lead to private operation of the space shuttle fleet.

If you want to explore Mars and support *your* space program, send your donation (minimum $1, made payable to the Viking Fund) to: The Viking Fund, P.O. Box 735, San Pablo, CA 94806. All donations are tax-deductible, and contributors will receive an open invitation to the dedication of the fund to support NASA, which will to be held in Washington, D.C. sometime in July 1980.

The ultimate success of the Viking Fund depends upon the ability of space-program supporters to put their money where their mouths are and fund space activities themselves. It doesn't take that much money. If each *Omni* reader contributed $1, the fund would reach its goal, *Viking*'s data would bring Mars one step closer, and a message would be delivered to Congress via the medium we all understand — money. So if you've spent your dollars to see the exciting fantasies *Star Wars* and *Star Trek*, then why not contribute to the exciting reality of exploring Mars? It just may be the best investment you'll ever make. ∞

Stan Kent is chairman of the Viking Fund and of the San Francisco section of the American Astronautical Society.

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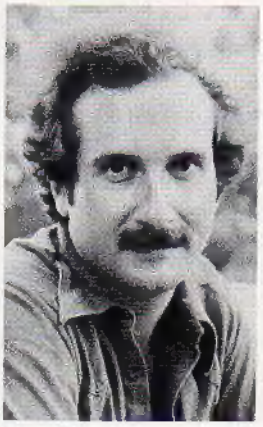

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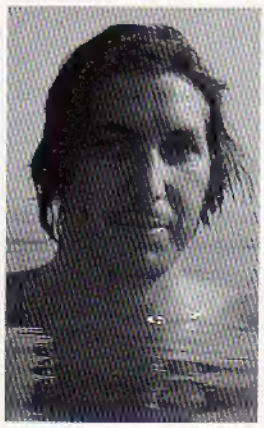

WOLFF

KIRKLAND

CAMOIN

This month one of the nation's most bizarre rituals is examined by screenwriter *Richard Chapman*. "Brain Wars" (page 44) takes an up-close look at the extracurricular hijinx of Caltech students as they celebrate Ditch Day. Chapman says he got the idea for the piece while researching a screenplay that dealt with how young geniuses survive four years at the California Institute of Technology. The film will be a comedy, exploring life in the intellectual fast lane, illustrating that the "individuals our society derisively labels eggheads are not hard-boiled automatons but, rather, a delightful omelet of creativity, warmth, and wit, with hearts as large as their brains." Chapman has produced feature films and is affiliated with Columbia Pictures.

"I fear that the grave potentials of space warfare have yet to be impressed upon the American public," says famed novelist *James A. Michener*. In "Looking Toward Space" (page 56) Michener explores the lack of a comprehensive U.S. space effort. Born in New York City in 1907, Michener launched his career by editing textbooks for a New York firm—a position that was interrupted by World War II. His wartime experiences in the Solomon Islands provided Michener with the idea for his first book, *Tales of the South Pacific*. Other Michener best-sellers are *The Bridges at Toko-Ri*, *Caravans*, *Hawaii*, and *The Source*.

The American Institute of Aeronautics and Astronautics is sponsoring a spectacular display of technology and hardware in Baltimore this month. The exhibition, designated Global Technology 2000, will present the latest in space equipment, wind turbines, blimps, and other devices manufactured by some 250 aerospace companies. Just in case Baltimore is not on your itinerary, you'll be able to sample this impressive technology of the future in a glittering photo pictorial entitled "GT 2000" (page 76). The gallery, produced by photojournalist *Anthony Wolff*, is a montage of photographs shot mostly by Wolff and photographer *Douglas Kirkland*. Kirkland was a staff photographer with *Life* and *Look* magazines for many years and has put together an impressive portfolio containing candid photos of many favorite celebrities.

This month's Earth column, "Ecocide" (page 14), is provided by conservation specialist *Dr. Norman Myers*. Dr. Myers recently published *The Sinking Ark* (Pergamon Press). He has also completed a survey for the National Academy of Sciences on tropical forests, the report on which has just been released by the National Research Council, Washington, D.C. In *Omni*, Myers discusses the disappearance of lesser-known species, such as rare tropical plants and insects. Eventually these losses will affect the biosphere of the entire planet.

Although we cannot yet control the engines and masses required to make a time machine, we know the principles behind time travel. That's what physicist and science writer *Dr. Robert L. Forward* says, and in "How to Build a Time Machine" the good doctor provides all the details. It starts on page 92. As a visual complement to Dr. Forward's article, we present "Time Travelers," a stunning collection of original art (page 96). The first painting, *Ring Driver*, is the collaborative effort of two artists, *Richard Lon Cohen* and *Jon Townley*. The artists work from their studio in Columbus, Ohio, and have done covers for *Heavy Metal* magazine and Dell, Ace, and Scribner's.

Omni's May fiction features writers *Tom Disch* ("Josie and the Elevator," page 50) and *François Camoin* ("Some of My Best Friends Are Americans," page 102). The first tells about elevators and what might happen if you're not nice to one. Camoin's story is a grim one in which Americans have become vassals without rights in their own country.

Finally, economist *Hazel Henderson* discusses alternative futures in this month's Interview (page 86), and aerospace engineer *Stan Kent* makes a plea for the Viking Fund in "First Word" (page 6).

We are pleased to announce that our profile of astronomer Stephen Hawking ("The Wizard of Space and Time," by Dennis Overbye, February 1979) has received the 1980 American Institute of Physics Award for Journalism. This prestigious acknowledgment is given each year to the one article that best explains the science of physics to the layman.

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LETTERS

COMMUNICATIONS

Ground-In Dirt

In his account of Leon Lederman's appearance on the Phil Donahue show [People, February 1980], Dick Teresi writes, "Oddly enough, the high-energy physicist proved to be a big hit with the ladies."

What's so odd about women being interested in physics?

Undoubtedly, there was a time when an interest in the physical world was considered unladylike. But nowadays an understanding of particle physics is a must for getting out really ground-in dirt.

Janice M. Fillip
Los Angeles, Calif.

Dick Teresi replies: *If you'll reread my column, you'll see that I did not find it odd that women were interested in physics, but in a* physicist. *Talk shows such as Donahue's normally feature doctors, politicians, movie stars, movie stars' wives, politicians' wives, and sexual deviants of all possible description. But physicists? How many times was Isaac Newton invited on early morning television? And what about James Clerk Maxwell? Here the man gives the world four equations explaining the electromagnetic effect, thus making the very existence of television possible, and he doesn't even rate an appearance on* The Gong Show.

Seriously, I did not intend to demean women by implying they would not be interested in physics. I was simply making a comment on the rarity of a physicist showing up on the tube, and Donahue is to be commended for inviting Lederman on his show. Still, Donahue revealed some insecurity toward his guest in the opening statements of the show, to wit: "This is going to be interesting. I mean, maybe it'll be interesting." As it turned out, there were no "maybes" about it.

As for your ground-in dirt, I'd recommend adding half a cup of antiquarks during the rinse cycle. This will annihilate any stain within 10^{30} *years.*

Paying Through the Nose

I've just finished reading the article by Scot Morris entitled "Prizes" [December 1979] and feel compelled to make a few comments.

First of all, the so-called $10,000 "prize" offered by Mr. Philip Klass for proof of extraterrestrial UFO visits in the twentieth century is a bet, not a prize. Those of us ufologists who have taken that bet must pay Mr. Klass $100 per year up to ten years, against his promise to pay us $10,000 should we demonstrate such UFO proof as long as we both are alive.

Considering that Mr. Klass is about 25 years older than I, I'm essentially betting that the proof will come in the next ten years or so. I've already paid five times. Mr. Klass is risking little: He has several people paying in, and he has put up no money. If the proof is forthcoming, our own currency will have the same value as Polynesian shells and coconut husks had for visiting Europeans and Americans. His estate is not liable; so he can't really lose.

Even taking all these factors into account, I took him up on the bet. I believe I am right, and I'm willing to back up my belief. Anyway, it's great fun and a fine conversational topic.

One does wonder, however, why Mr. Klass excluded all but the twentieth century from the bet. Is he not telling something?

Arlan K. Andrews
Indianapolis, Ind.

Heavenly Peace

In regard to the item on astro burial [Continuum, February 1980], I had begun drawing plans to develop the Interstellar Burial Corporation. Why, for goodness sake, spend $3,000 to get your cremated remains lofted into Earth orbit? If NASA requires $1.8 million for room in the main cargo hold of the space shuttle, why not take a lease out on immortality?

I am drawing up a charter for members to be cryogenically suspended at death. These frozen bodies will be put in specially made capsules, placed in racks to accommodate the cargo space interior with propulsion systems to launch the capsules into interstellar trajectories. Capsules could also be launched in highly elliptical and eccentric orbits so that they

CONTINUED ON PAGE 136

DIALOGUE

FORUM

In which the readers, editors, and correspondents discuss topics arising out of Omni *and theories and speculation of general interest are brought forth. The views published are not necessarily those of the editors. Letters for publication should be mailed to* Omni *Forum, Omni Magazine, 909 Third Avenue, New York, NY 10022.*

The Good Life

I really enjoyed the article "The Good Life Underground" [January 1980], by Mike Edelhart; however, it did not tell where to get more information on building underground homes. Fuel costs are going sky-high. So when I build my home, I would like to build an energy-efficient habitat underground. I would be interested in corresponding with some people who already have an underground house to see what they like and don't like.

Scott R. Garcia
Hollister, Calif.

I would like to obtain more information on how to build an underground home, together with blueprints and diagrams. Could you please send further details about the companies and individuals that design underground homes?

Daniel John Macke
Cincinnati, Ohio

Mike Edelhart replies: *I'm gratified, and overwhelmed, by the response to the underground housing article. You can write these people for assistance. The single best source is: Earth Sheltered Housing Design, The Underground Space Center, 11 Mines and Metallurgy Bldg., 221 Church Street, S.E., Minneapolis, MN 55455. Send $10 (prepaid). They have a complete list of underground houses, designs, architects, and suppliers. Other good sources: Malcolm Wells, P.O. Box 1149, Brewster, MA 02631; John Barnard, 1054 Main Street, Osterville, MA 02655.*

The Voice of Reason

Ben Bova's editorial in *Omni*'s February issue rightly calls attention to some of the truly remarkable strides science has made, eradicating several killer diseases of the past; it also singles out the ungrateful "shock troops of ignorance" who tend to place the blame for society's ills on the head of science. However, it is difficult to see how this small, myopic group could ever "destroy science" simply by demonstrating and shouting, "No more nukes," "No research on intelligence," or, "No DNA experiments."

The ability of science to control the monsters it creates is the legitimate concern of citizens and deserves an answer, not pious ridicule. The voice of reason does not cry, "Stop scientific research," or, "Proceed at all cost." Reason says, "Let science proceed—with caution and wisdom to match."

Rulon Hacking
Taos, N.M.

Shame on Ben Bova, using a national forum like *Omni* to call people names.

His editorial in February seems to be making the argument that since medical science has wrought miracles that have revolutionized everyone's life, anyone questioning technological activities or advocating controlled testing and development is a member of "the armies of ignorance."

Regulation of medical science is not meant to hamper research but to try to prevent tragedies such as those caused by Thalidomide and DES. The aim of the regulators is the same as that of the researchers—to secure benefits to humanity. The same concerns that apply to medical science should guide progress in other technological fields. The potential for damage is so great in areas like nuclear power, toxic chemical production, and genetic engineering that regulation should be proportionally cautious. Scientists have been working on the problems of containerization, shipment, and disposal of radioactive waste for 40 years without a solution. It seems reasonable that the problems should be solved before 200 nuclear-power plants are built, not to build in anticipation of a solution.

I hope that Mr. Bova would agree that reasonable and thoughtful people can work together by these methods to reach new horizons.

Vicki Black
Denver, Colo.

Going underground: clean and efficient.

Ben Bova replies: *It is fascinating to see how people howl when they are on the receiving end of an emotional argument. If my line about "shock troops of the armies of ignorance" has caused readers to open their eyes, good.*

Civilizations have been destroyed by barbarians in the past. We must be aware our civilization could be destroyed by those armies of ignorance that use slogans in place of rational thought.

I have no quarrel with those who have examined the evidence on nuclear power and have drawn conclusions that disagree with my own. It's the slogan-shouting mobs that bother me. They are too easily manipulated, and when they run out of one cause to protest against, they find another—even if someone has to create it for them.

As far as nuclear power is concerned, it is far safer and less carcinogenic than coal. We all look forward to the day when solar energy will solve our problems. But until then it is nuclear power that provides the electricity for my home; without it we would be freezing in the dark.

CONTINUED ON PAGE 134

ECOCIDE

EARTH

By Norman Myers

We are destroying—killing off irrevocably—at least one plant or animal species every day, each day of the year. If present trends continue, we may lose one species per hour by the end of the decade. In all, we risk the possibility of wiping out 1 million of the earth's estimated 5 million to 10 million species by the year 2000.

What is the basis for this dismal prognosis? Is the outlook really this bleak?

In the past the animals that we have recognized as endangered species have been the more obvious or endearing creatures: whales, tigers, whooping cranes, or bald eagles. But other types of species are far more numerous. Insects, for example, number in the millions (no one knows exactly how many), compared to the 42,000 known vertebrates (mammals, birds, fishes, reptiles, and amphibians). If we could document these myriad creatures—along with the thousands of unknown plant species that exist—we might find that hundreds of thousands of species are actually being pushed toward extinction. The cause: destruction of habitats by man's insatiable need for raw materials, such as lumber and minerals.

Moreover, the problem is even more critical in areas we know little about. Moist tropical forests cover less than 10 percent of the earth's surface yet contain 40 to 50 percent of the earth's species. These forests are being destroyed on an alarming scale by unrestricted logging. Many of these forests are unlikely to survive in their present form past the end of the century if we don't change our ways.

Unlike temperate-forest species, which are far less abundant, tropical-forest species tend to have specialized ecological requirements or are limited to habitats totaling just a few hundred square kilometers. This leaves them extremely susceptible to extinction once their environment has been destroyed. The first wave of mass extinctions is already occurring in the rainforests of Southeast Asia, a biological treasure house to the scientist and a commercial gold mine to business interests. (Similarly, ecosystem destruction imperils other species-rich habitats, such as coral reefs and wetlands.)

Tigers are among the endangered species we are losing at the rate of one per day each year.

Man's domination over creation is a wholly new situation. It implies a total responsibility, a consideration of how evolution works to create the diversity so beneficial to us.

One of the apparent rules of evolution suggests that an outburst of extinctions may lead to an explosion of speciation, the process whereby new species come into existence. Large numbers of niches, or "ecological living spaces," will open, enabling new species to occupy them. And with these new niches will come the stimulation for speciation.

Unfortunately, the organisms that occupy these new niches are by definition opportunistic, pioneering types. We already have some examples of these "clever" species in our immediate environment: rats, sparrows, starlings, cockroaches, and "weedy" plants, to name a few. Thus, we may plague the world with the worst kinds of creatures—a prospect all the more troublesome if we've also eliminated the predators and parasites that keep these opportunistic species in check.

One compelling reason for saving wild species is their intrinsic economic value. Of the 1 percent of *all* species that have been investigated for their economic value, many thousands already make sizable contributions to food, medicine, and industry. Extinction of the huge, uncategorized, and unknown quantities of creatures precludes their making a contribution that may benefit humankind.

For example, we can't know which of the earth's 250,000 plant species—one third of which are edible—may make a substantial contribution to future diets. Humans have used only 3,000 of these for food throughout history, and fewer than 20 kinds of plants—notably rice, corn, wheat, and soybeans—presently account for 90 percent of the food we consume daily. A survey conducted by the National

CONTINUED ON PAGE 125

GALACTIC GERMS

LIFE

By Dr. Bernard Dixon

The notion that Earth was originally "seeded" with living organisms from space has now taken on a modern guise. Sir Fred Hoyle, the eminent cosmologist, has revised the theory to explain why unwelcome viruses arrive to plague us even today.

Diseases from Space, which Hoyle has written with Professor Chandra Wickramasinghe, is being published in the United States in June. The book is destined to cause a sensation because of renewed concern over the origin of novel strains of influenza. Does Hoyle provide a convincing answer?

In his earlier work Hoyle theorized that some 4 billion years ago comets ferried prebiotic substances to our planet. Then micrometeors brought life itself. But do clouds of viruses continue raining down upon us, accounting for intermittent ravages of such infections as influenza, cholera, or even the common cold? At this point the story takes off into what most microbiologists regard as science fiction.

The main thrust of Hoyle's argument is that outbreaks occur just as if the microbes responsible were arriving sporadically and vertically instead of being transmitted horizontally across the earth's skin from person to person. At Eton College and schools in Cardiff, Wales, for example, some students' living quarters have been heavily affected by influenza while others have not been affected. The infection is not distributed randomly, as one would expect if people were passing the virus one to another.

Critics of this hypothesis focus on three points. First, microbes could not tolerate radiation in outer space. Second, we understand perfectly well how new influenza viruses arise, by genetic recombination among old ones. Third, it is inconceivable that microorganisms generated in space should be so exquisitely engineered as to invade the human respiratory tract.

The first objection can be answered, not just plausibly, but devastatingly. Bacteria and viruses have highly efficient mechanisms to repair damage caused by ultraviolet light at wavelengths they do *not* experience on Earth. But to argue, as the skeptics do, that these evolved to sustain microbes before this planet acquired an atmosphere evades an important point. Why should such machinery have endured for billions of years after it was no longer required? Hoyle's reply: The machinery exists so microbes can journey safely to Earth.

The alarming feature of the second skeptical argument is that, although textbooks assuredly present a satisfying picture of how flu viruses originate and develop, the past few months have seen renewed controversy over the whole subject. *The Lancet* (1980, *1*, 186), for example, pointed out that we still need proper evidence to show how flu viruses survive so efficiently; work by Dr. R. E. Hope-Smith, which suggests that flu virus does *not* persist in the community by being transmitted between people, was cited in the *Lancet* article. Dr. Hope-Smith's answer is that the virus lies latent, but this is no more than speculation. Scientists at the Mount Sinai School of Medicine, in New York City, are still puzzling over why the so-called H1N1 virus reemerged in 1977 after "disappearing" in the late 1950s (*Proc. Nat. Acad. Sci.*, *76*, 6547). Amid such uncertainty can anyone afford to dismiss Hoyle's hypotheses?

We must take the third criticism more seriously. Why is influenza virus so beautifully designed to invade the respiratory tract of *Homo sapiens* if it is a product of interstellar space? The staggering complexity of flu virus—with components perfectly adapted to penetrate particular tissues and then mobilize the cells' machinery to fabricate new particles—surely supports the idea that it originated on Earth, not in space far from the dictates of organic evolution.

Nonetheless, the practical implications of this possibility are disturbing. If influenza and other plagues really do emerge in outer space, our skill in dealing with them is undoubtedly built on shakier foundations than we had supposed. Could fear make us less inclined to accept such an idea?

If comets ferried the first germs of life to Earth, could they be present-day carriers of disease?

ASTEROID AGRICULTURE

SPACE

By Brian O'Leary

"The world hunger problem is getting worse rather than better," said the recent report of the Presidential Commission on World Hunger. "A major crisis of global food supply—of even more serious dimensions than the present energy crisis—appears likely within the next 20 years, unless steps are taken now. . . . Moral obligation alone would justify giving highest priority to the task of overcoming hunger."

This assessment is neither new nor uncorroborated. For years, agricultural scientists have been warning us of some ominous trends: The food supply is dwindling as the world's population grows. Water resources are becoming even scarcer in potential crop areas. The use of fertilizers is creating environmental damage, including possible ozone depletion in the atmosphere. Drought and severe climatic conditions continue to cause fluctuations in food production.

The increasing genetic uniformity of crops also creates problems. By developing fewer strains of food plants, we make them more vulnerable to disease. This could cause widespread shortages and famine.

Terrestrial solutions of the world food problem are elusive. The development of modern agriculture—the so-called Green Revolution (efforts over the last 20 years to grow more food per acre in poor countries)—bought some time but appears to have reached its limits. Nobody seems interested in meeting the high capital costs of intensified, controlled-environment agriculture in greenhouses. And agronomists believe that U.S. food production, once regarded as mankind's ultimate ace in the hole, has now plateaued. "The rate of growth of agriculture production has slowed down," says Anson Bertrand, of the U.S. Department of Agriculture. "We see this leveling off not only in the United States but globally as well."

What are our chances of growing food in space? The Soviet Union is well on its way to proving that space agriculture is feasible. The Russians have isolated people for up to six months in closed environments, where they have successfully grown wheat and made bread. They've done experiments in space, too, preparing for long-term, agriculturally self-supporting, orbiting settlements.

Self-supporting asteroid farms could begin to ease Earth's food shortage in 30 years.

A number of scientists in the United States have investigated the feasibility of carrying on intensive agriculture in space to supply food for the inhabitants of space settlements. Grains, bread, poultry, and pigs could be raised in closed agricultural areas adjacent to orbiting colonies, where light, temperature, and moisture can be varied according to the requirements of a particular crop.

Space inhabitants could develop the full complement of crops and livestock instead of resorting to the dullness of dehydrated foods and Tang, about which the astronauts have complained. Droughts, pests, and pervasive disease—even the passage of seasons—could be eliminated. Fertilizer could be produced in space by using solar heat to combine nitrogen and oxygen from the asteroids.The supply of materials available for agricultural facilities would grow exponentially as colonies were completed; so it would be possible to construct huge areas for growing food in space. Although the workability of closed agricultural ecologies has not yet been conclusively verified, it appears likely that, sooner or later, food will be grown successfully in space.

Recent engineering studies suggest that our most cost-effective means of supplying electricity could be to build satellite solar-power stations and send their output to Earth via microwave links. The stations would be built in space of materials retrieved from the shallow gravity wells of the moon and asteroids. One study showed that a lunar mining and launching facility and a space chemical-processing plant could be built for between $5 million and $10 million. The first satellite power station would be completed only two years later.

Even if satellite power does not turn out to be the primary incentive for developing the resources of space, the study concluded that lunar materials could be

CONTINUED ON PAGE 127

THE ARTS

By Sam Bruskin

Max Mathews invented computer music in a display window at IBM's headquarters in New York City. That was in 1957. Nearly a quarter century later Dr. Mathews, now director of acoustic and behavioral research at Bell Laboratories, continues to maintain his involvement with computers and music—an unbroken duet. Mathews, in fact, is one of the foremost advocates of the collaboration of scientists and artists that goes leapfrogging through modern history.

Mathews has consistently recognized the point at which artistic advances produce scientific response. He calls for scientists to recognize their responsibility to art—to make innovations in technology available to the artist.

At his home in Murray Hill, New Jersey, over a beer and supper, this pioneer of sound and speech processing gave *Omni* a short course in computer music.

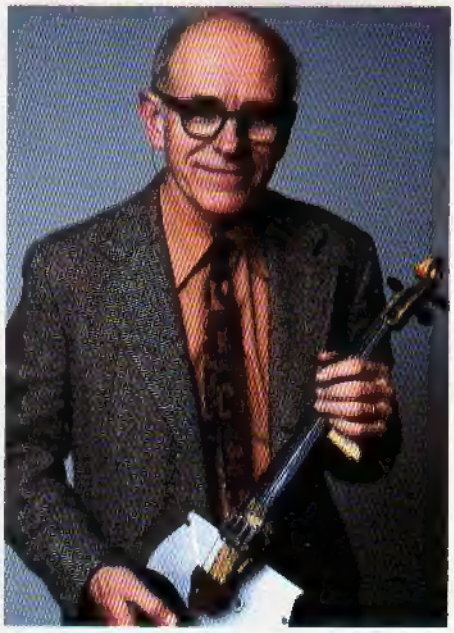
By researching speech analysis—central to automatic speech recognition and low-channel-capacity speech transmission—Mathews and his colleagues developed the first methods for simulating telephones on computers. "That meant when we wanted to try a new phone, we didn't actually have to build it," he said. "We could simply write a computer program at one end. The speech passed through the program, and you heard it at the other end as if it had gone through the real telephone." This work was fundamental to the development of computer music.

The basic principle for making computer-generated speech or music, Mathews says, is the digitization of sound. "Sound is a pressure wave in the air that changes rapidly from instant to instant," he explains. "We measure these changes very frequently; I'd say thirty thousand times each second. On a computer each of these measurements becomes a number, so that a second's worth of sound is thirty thousand numbers." By this technique, called digital-to-analog conversion, any sound heard by the human ear can be reproduced from numbers.

This is theoretically the most attractive advantage of the computer as musical instrument: "It can make the sound of any instrument that exists today or of any instrument that anyone can possibly conceive of making in the future."

For Mathews, this relationship between music and the computer started one night in 1957 when he attended a piano recital with his friend John Pierce. "The Schönberg was quite good," Mathews recalls, "but the Schnabel was awful. During the intermission Pierce and I looked at each other, and we agreed, 'The computer ought to be able to do better than this!' So I tried writing a program to synthesize music." Mathews rented time on the IBM 707, a machine so new at the time that the only available model he could rent was on display. Hence, the computer scientist in the show window.

"That was Music I," he says. "It was a simple program: It had only one voice, one timbre, one loudness, one attack and decay—and produced terrible sounds." Mathews continued to produce the Music program, writing Music II, III, IV, and V, which is in general use today. "Other people started asking for copies of Music V and started working in their various places." John Chowning, at Stanford University, developed Music 10 for another kind of computer; Barry Vercoe wrote Music 360 for the IBM 360. Computer music was here to stay.



Mathews: integrating circuits to make music.

In creating computer-music software, the first problem Mathews encountered was programming: how to calculate the 30,000 digits per second of sound. "You can't ask the composer to write down each individual number; that's too much work. You have to get an ingenious program that lets the composer decide what he wants to control—such as pitch, loudness, duration, and starting time of the notes. That should be all he has to write on the score. That's what Music I really does. It takes the relatively brief descriptions by the composers and generates the very detailed sound wave."

There was another major obstacle to generating computer music, the question Mathews found the most challenging. He calls it the psychoacoustic problem. In a physical sense, he says, we do not understand why sound waves produce a given impression or timbre. With traditional instruments one need not understand the physical sound wave. The musician has only to understand the instrument that is producing it. Not so with the computer: Everything is new, and one has to specify everything about the sound wave.

"You have to understand sound and its effect on the ear in a much more fundamental sense than ever before," Mathews comments. Musicians of the future might study not only music theory but also computer programming, acoustics, and the physiology of hearing.

Mathews began work on the psychoacoustic problem with French composer and physicist Jean-Claude Risset. "Risset studied the trumpet to understand what made a brass sound brasslike. Basically, people in the past were guessing what produced brass sounds, but Risset had the computer to test out his hunches. He could get some trumpet tones that were indistinguishable from actual ones. We called this technique

analysis by synthesis, and because of it we understand far more about normal instruments now than we did back in the Fifties."

The state of the art in computer music is real-time sound synthesis. "In the last ten years people have built special-purpose digital circuits that are fast enough to calculate one second's worth of sound in one second," the composer says. "They couldn't before. Now you can make a computer instrument that can be played like a normal instrument—that is, a performer can perform on it."

Analog synthesizers, such as the well-known Moog, are quite different from computer instruments. Mathews describes the synthesizer as a "machine that generates and modifies an electrical signal and eventually applies it to a loudspeaker and gets an acoustic signal. It contains oscillators to generate signals at various pitches, filters to modify the spectrum and timbre, and generators to start and stop the oscillators at the beginning and end of notes."

"The computer, however, is actually a memory unit holding a lot of numbers—a calculating machine that can add, subtract, multiply, and divide those numbers. Of course you must have a program to make this unit calculate numbers that sound like music when you convert them to sound. Although they do it in different ways, the synthesizer and the computer can do the same job, but the computer is able to do more."

Yet there are "dumb ways to play intelligent machines." Mathews calls one of them the organ mode. "When someone plays a computer like a traditional piano or organ—one note at a time—he wastes the instrument's potential. Another—he refers to as the tape-recorded mode, where one puts the entire score of the composition into the computer, presses the button, and lets the machine perform the entire piece. "This is unsatisfactory both to the performer and to the audience. The performer doesn't think he's expressing himself, and the audience don't think they're hearing a performance."

Other modes characteristic of music-making computers are more interesting. Mathews refers, for instance, to John Appleton and his Synclavier. "One of Appleton's techniques I call the music-minus-one mode. He programs several voices into the Synclavier's memory that play themselves automatically. Then he performs one or more voices on the instrument's keyboard in synchrony with the voices that come from the memory. If he's feeling especially vigorous some night, he can play all the voices, and if he's feeling especially lazy, he can downplay them, play either one or two of the voices or play none of them."

There is another manifestation Mathews calls the conductor mode. "I arranged an electric baton, if you will, to control the computer. Many of the functions of a conductor are accomplished with this device. It sets tempos and balances the voices. It goes through a rehearsal phase. It puts the right information in the memory—information a conductor couldn't put in during the performance. The musicians must be trained in advance, and the computer is especially nice in that respect. Once trained, it never forgets."

Mathews also invented a musician-machine interaction that he calls the sequential percussion device. "You hit the surface of this two-foot rectangle like a normal drum, but the impact doesn't produce a sound. Instead it produces three electrical signals. The computer generates the sound from the three signals."

One signal is proportional to how hard one hits the drum. "Usually I use this signal to initiate a note. It detects the fact that the drum is hit and determines how loud the note should be. This is the rather traditional use. The two other signals are

> *"The Schönberg was good, but the Schnabel was awful. During intermission Pierce and I looked at each other and agreed that the computer ought to be able to do better than this."*

the X and the Y coordinates, where you hit the drum. I usually use these to control the timbre of the sound being played. I use X to control the decay time of the note. Hit on the right it decays slowly, on the left, rapidly. I use Y to control the richness of the timbre. If I hit the drum at the top I get a large harmonic content—a rich somewhat harsh sound. If I hit the drum near the bottom it produces a smooth sound."

What's sequential about it? "The pitch. The drum is tuned like timpani. It can play different pitches. The score is put into the computer ahead of time, as a sequence of pitches. Each time I hit the drum I get the next note in the sequence automatically."

There is a philosophy of instrument-as-slave behind this sequential madness, and Mathews defends it: "Pitch, in the majority of musical styles, is one of the parameters the performer has no freedom about. He must play the pitch the composer has specified, or he is considered to have played a sour note. Well, it seemed to me that anything the performer had no control over he shouldn't have to control. So I said, 'All right, let's give the pitch control to the computer.' The obvious way to do it is with a sequential control mechanism and a score. So far I've only built this drum, a monophonic instrument. But think about sequential control of pitches applied to a polyphonic voice—a whole orchestra of voices."

At the heart of this science-art interface is the relationship between the people involved. Mathews, the scientist, has worked extensively with musicians and composers. He himself is an avid violinist, and he enjoys demonstrating the bodiless electric violin that he developed.

"I think the relationship between a scientist and an artist can be a very personal one. For some time I worked at IRCAM [Institute for Research in the Coordination of Acoustics and Music] in France, with Pierre Boulez. The institute is a mixture of musicians and scientists, and through that I've come to understand more the difference between these two kinds of people.

"It concerns what one's looking for in life. Scientists, in general, get kicks out of solving problems, discovering something about the nature of the world. The musician—the artist in general—gets his kicks out of experiencing emotions, so the musician really has to experience the music almost on a daily basis. If he doesn't, he feels dissatisfied. The scientist, however, is dissatisfied if he's unable to solve the problem that he's working on, unable to discover something new. I think the creative process is similar in both cases."

Where will this relationship of musician and computer take us? Will the computer, the tool, shape human forms into more machinelike images?

"I don't think the function of the computer will be to depreciate music," Mathews says. "I trust that as a result of the computer's facility people will be able to appreciate music more.

"Computers will add a new dimension to music, especially the home computer. It will be sufficiently easier to play so that many people who otherwise could only listen to music will become active musicians. This may be the biggest accomplishment of the home computer market."

Automatic speech synthesis and speech recognition, too, are changing the relationship between machines and people. "We now have complicated, large-scale integrated circuits that make it possible to build powerful and practical speech recognizers," Mathews points out. "It's clear that we can use these devices to communicate between people and computers. Machines will be able to speak to people, and speaking is a very effective way to communicate. Humans in a limited way at least, will be able to speak to machines, and the machines will understand the voice commands given to them."

UFO UPDATE

By James Oberg

One major difficulty in explaining the UFOs seen by honest, sober, clearheaded, and clear-eyed witnesses is: There are hundreds of prosaic and explainable ways in which people can be fooled by their own senses. The stories that come out of those misperceptions are frequently as fantastic as the UFO stories that remain "true." Where can the line be drawn?

The files of J. Allen Hynek's Center for UFO Studies provide good examples of the problems facing UFO investigators who try to differentiate between UFOs and IFOs (identified flying objects) based on the "strangeness" of the eyewitness accounts. On April 29, 1978, ten different people called the Aurora, Illinois, police department to report a UFO. The object appeared to be a saucer flying at treetop level, although size estimates ranged from about eight meters across to "as big as a football field." After hovering motionless, the object then shot off eastward "in the blink of an eye." Several witnesses were badly shaken by the experience.

The plane, which admittedly looked quite strange from certain angles, became a UFO because, according to the report, "the pervasive emotional climate that appears to be surrounding the entire UFO subject succeeds in distorting even the most commonplace sightings into exaggerated miracles." This trap is one that UFO investigators all too frequently fail to avoid when presented with earnest, honest UFO reports.

True believers insist that their phenomenon is real because hundreds of high-quality eyewitness reports and dozens of photographs exist that have not been exposed as hoaxes. But photography expert Robert Sheaffer claims that if this proves UFOs are real, then people have got to believe in fairies, too.

"The evidence for fairies is at least as good as the evidence for UFOs," Sheaffer has written, tongue only partly in cheek. "There are books full of eyewitness reports, and photographs, too."

One of the most ardent pro-fairy spokesmen was noted British author Sir Arthur Conan Doyle, the creator of Sherlock Holmes. Doyle wrote *The Coming of the Fairies* in 1921, claiming that by all laws of scientific evidence, the existence of little creatures in gauzy clothes, playing panpipes, could not be legitimately denied. Sheaffer needless to say, is incredulous about fairies, but he has been unable to persuade many UFO buffs not to believe in them.

Philip J. Klass has also been routinely setting off multimegaton detonations among the ranks of UFO believers. Miffed when UFO experts in 1968 ridiculed a serious (and still tenable) suggestion that many UFOs were actually ball lightning, the by-nature combative aviation reporter threw himself into serious investigations of what were regarded as the best classic UFO cases. He often dug up startling (and embarrassing) new evidence, but he has become a pariah among UFO circles.

With the death of astronomer Donald Menzel in 1976, Klass has emerged as the nation's leading UFO skeptic. He spurns the word *debunker*, which connotes knee-jerk dismissals of novel or unorthodox points of view. Instead, he attempts to investigate UFO cases more deeply than might other researchers who have subconscious desires to find actual proof of extraterrestrial visitors. Concentrating only on the generally acclaimed "best cases," Klass has often exposed the superficiality of work done by pro-UFO experts.

In 1977 Klass joined with scientists and educators to form the Committee for the Scientific Investigation of Claims of the Paranormal, a group that has denounced the easy acceptance by the public of allegedly baseless beliefs in astrology, the Bermuda Triangle, ESP, "ancient astronauts," and other "modern myths." Klass heads a small but potent band of skeptical investigators called the UFO Subcommittee (Sheaffer is also a member). At the very least, this group demands the tightening of standards in so-called scientific ufology. The level of carelessness of many pro-UFO experts has markedly declined, and so progress is being made. OMNI

Lenticular clouds, such as this one near Mount McKinley, are key sources of UFO misperception.

CONTINUUM

A "MANHATTAN PROJECT" FOR ENERGY?

When the Arabs imposed their oil embargo in 1973 President Nixon called for a "Manhattan Project" for energy. This was an announcement of some interest to the veterans of World War II's Manhattan Project who remembered—vividly and fondly—their excitement and personal dedication in constructing a reactor for the first application of nuclear fission and then, fearful that the Nazis might obtain a nuclear weapon first, racing to make an atomic bomb.

Those of us who were involved in that effort recalled that the project had enlisted the very best physicists in the country: not just Fermi and Oppenheimer but Bethe, Feynman, Segrè, Alvarez, Seaborg, Chamberlain, McMillan—all Nobel laureates-to-be. Even among scientists of lesser stature there was tremendous psychological pressure to do their best and a sense of urgency, of importance, of being indispensable. The project was directed by General Leslie R. Groves, an army engineer, but he had the advice of respected elder statesmen of science, J. B. Conant, Vannevar Bush, and Arthur Compton; so the conditions of work were sympathetic. Under the exigencies of wartime, formalities were set aside. It was an extremely expensive undertaking and a gamble at that. At Los Alamos we were "living in anticipation of a congressional investigation" with petty economies such as no street lighting and wretched coal cooking stoves. Still, the work itself was never hampered by lack of money. Could the United States, faced with its energy crisis, duplicate the Manhattan Project in terms of the devotion and quality of its personnel and in terms of financial and moral support?

Has the United States even tried? Since Nixon's call for self-sufficiency, we have seen an alarming increase in our dependence on imported oil, affecting our foreign policy and devastating our economy. What was cause for concern in 1973 is a clear and present danger today. During those years the AEC became ERDA, which in turn was transmogrified into the Department of Energy. With each name change, it became bigger, more cumbersome, less flexible. It is now a swollen monster that is a far cry from the tidy Manhattan Project.

It is certainly late in the game to urge the President and his advisers to pursue a more productive course, but it will never get earlier. What can be learned from the Manhattan Project is that scientists work best in a climate in which they feel urgently needed and where their technical needs are quickly met.

When Chinese Deputy Prime Minister Deng Xiaoping came to Washington in 1979 *specifically* to forge three scientific agreements, it was symptomatic that the president's guest list, replete with stars of stage and screen, was astonishingly shy on American men of science. What might well have been a celebration of America's high-energy physics, space technology, and astronomy was instead a showcase for Shirley MacLaine and others from Hollywood. Given such direction from the top, it's no wonder that Jane Fonda's opinions on energy receive more attention from the media than Hans Bethe's.

The very best encouragement to fruitful scientific work, of course, isn't encomium but financial support. To the uninformed, money so spent seems wasteful. Twentieth-century science is certainly expensive, but it is the only hope for the kind of miraculous "breakthrough" such as fusion that would enable us to turn a million turbines with water from the sea. The scientific basis for fusion is as firm as it was for fission when the Manhattan Project began. Representative Mike McCormack, a scientist himself, has introduced a bill in Congress to accelerate the fusion program, to make it a real national commitment similar to the Apollo Project or the Manhattan Project. For this gamble the ante is billions of dollars. Will we pay the price?

Funding alone is not enough without intelligent direction. "How can we accomplish much?" the director of one of our national laboratories laments. "It's ninety percent paperwork and ten percent planning!" Scientists spend so much of their day in one meeting after another that their hours of research are drastically cut. It is widely believed that the Department of Energy binds would-be giants in red tape. There are plenty of experienced administrators of the caliber of Conant and Bush in the United States, but few are in Washington, D.C.

Nixon was distracted from his goal of applying "the lessons of the Apollo Project and the earlier Manhattan Project" to our energy needs. Those lessons still remain the same: generous financing under qualified scientific direction without excessive bureaucratic restraints. If we heed them then, just as Nixon said, "We can do extraordinary things. We, who were with the Manhattan Project, think that we can." — *JANE S. WILSON*

CONTINUUM

THERMO-SKYSHIPS

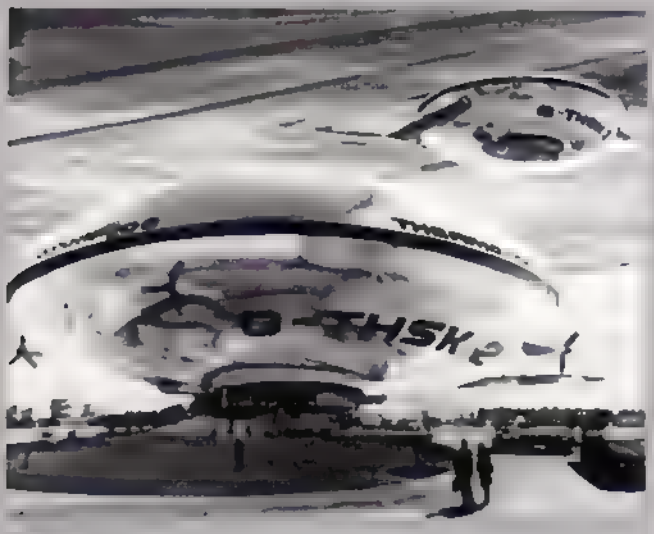
Commuters of the future will ride to work in blimps shaped like flying saucers if a British company called Thermo-Skyships Ltd., has its way. The company is trying to finance vertical-take-off-and-landing vehicles, combining aspects of both blimps and helicopters, that will be used to transport passengers and cargo over short distances.

This Thermo-Skyship 100 will use helium for its main lifting power and turboprop engines for thrust and will be capable of carrying up to ten tons and 100 passengers. Major advantages the Skyship 100 has over conventional ships include a shape and thrust system that ensure control even at low airspeeds and an ability to be easily anchored to the ground for loading and unloading.

Although not designed to replace long-haul airplanes the Thermo-Skyships, with a maximum speed of 90 knots, may actually reduce traveling time because they can land *within* selected cities rather than on the outskirts.

The revolutionary vehicles will also run almost as quietly as the Goodyear blimp. Passengers will be seated around the periphery where they can enjoy the scenery. By avoiding the traffic congestion that traditional forms of transportation create, Thermo-Skyships Ltd., plans to attract passengers who appreciate a quiet and efficient form of travel, even if it does look like a leftover prop from *Forbidden Planet*.

— Jane Bosveld



Radio-controlled commuter blimps in the shape of flying saucers may one day sail through British skies, powered by turboprop engines

"There is a hopeful symbolism in the fact that flags will not wave in a vacuum."

— Arthur C. Clarke

VEGETARIAN PETS

And now radical chic for the health-food set: vegetarian dogs and cats.

In a recent issue of *Prevention* magazine, among the ads for dolomite and vitamin E, a column by veterinarian Richard H. Pitcairn explains how vegetarians can wean their pets from animal tissue without subjecting them to physical side effects.

Dr. Pitcairn notes that dogs need 10 times as much protein as humans do per pound of body weight, cats need 20 times as much. So he prescribes a carefully balanced diet of rolled oats, brewer's yeast, brown rice, beans, cornmeal, cauliflower, bran, and kelp powder, among other things.

"I live in Santa Cruz [California], where there are a lot of vegetarians, compared with the rest of the country," Pitcairn said in an interview. "I recommended the [pet] diet to clients of mine who are vegetarians."

Beyond the matter of conscience, however, Pitcairn says his vegetarian pet diet could free conventional protein sources for people. While meaty pet foods occupy an entire aisle of many supermarkets, there is a growing shortage of high-quality protein for humans.

Pets may not respond as well to their new diet as do the animals at chow time on TV commercials. "Cats are particularly reluctant to change their eating habits, but they can be eased along by adding butter to some of the new fare," the magazine says. However, cats need a particular amino acid found mostly in animal tissue, so their alternative diet allows them two servings of meat or fish each week.

— Stuart Diamond

"We are such little men when the stars come out."

– Hermann Hagedorn

Your faithful dog or cat probably prefers horsemeat or tuna, but one expert explains how to transform them into veggie noshers

EDUCATIONAL ALCOHOL

Will alcohol one day become a tool for education? Will folks start drinking to remember rather than to forget? A recent study of mice shows that ethanol (pure booze—may enhance memory if it's ingested in moderate doses right after one learns something.

"Our experiment suggests that alcohol actually enhances memory," says Dr. Ronald L. Alkana, assistant pharmacology professor at the University of Southern California pharmacy school, who ran the project with Dr. Elizabeth S. Parker, of the National Institute on Alcohol Abuse and Alcoholism.

Whether alcohol registers the same effects in humans as it does in mice remains open to question. "It's dangerous to draw such conclusions from differing species," says Dr. Alkana.

The theory here is that ethanol helps the brain store information better for retrieval later on. In the study, mice were put in a lighted chamber connected to a Plexiglas alleyway that ran into a hole in a dark chamber. Because mice by instinct gravitate toward the dark, they scurried into the dark chamber, where they were jolted with a mild electric shock.

The mice injected with a saline solution right after this lesson took place averaged 80 seconds to cross over into the dark on a replay, but the mice given shots of ethanol averaged 190 seconds for the trip. While some might conclude this means the boozed-up mice were simply slowed down by the alcohol, Alkana's conclusion is that they delayed going into the dark because they remembered the electric shock better than the sober mice did.

The study postulates that alcohol can spark a kind of dialogue between nerve cells in the brain that can intensify memories both recent and distant. "It could help us understand better why people drink in the first place," Alkana speculates.

Robert Brody

Alcohol-injected mouse is dropped into testing chamber

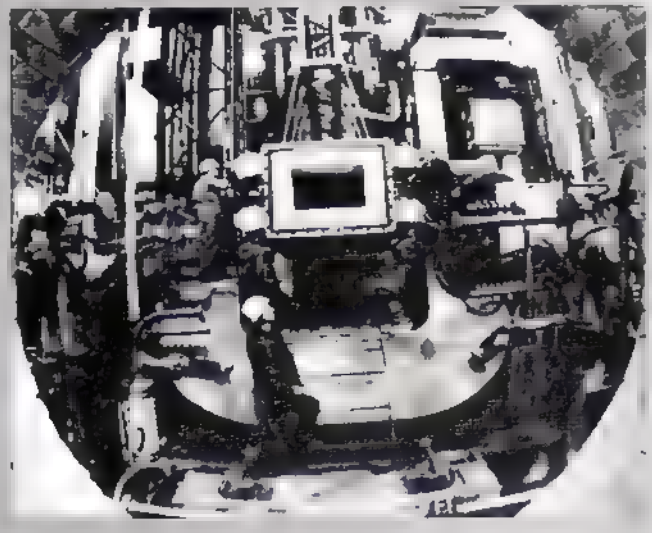
"The speculation . . . is interesting, but the impossibility of ever doing it is so certain that it is not practically useful."

- The editor of Popular Astronomy *in a rejection letter to Robert H. Goddard concerning his article "On the Possibility of Navigating Interplanetary Space," in which he proposed the idea of nuclear energy (1907)*

RED STAR POWER BOOST

The world's largest demonstration plant for the production of electricity using magnetohydrodynamics (MHD) is on the drawing boards in the Soviet Union. The Soviet Ministry of Power and Electrification recently announced plans to construct a 500-megawatt plant southeast of Moscow.

The attraction of MHD is its potential to increase the efficiency of generating electricity by burning fossil fuels. In an MHD generator an easily ionized element such as potassium is added to the hot gases produced by combustion, and the mixture is then passed through a magnetic field. The magnetic force deflects electrons in one direction and positive ions in the opposite direction, generating an electric current. After the hot gases pass through the MHD stage, they can be put through a conventional steam-power plant to produce more electricity. The MHD/steam-power plant combination can turn up to 60 percent of the combustion energy into electricity, contrasted with only 40 percent in a conventional plant.



Inside view of a Soviet MHD plant. The Russians predict they'll be turning out 10,000 megawatts in the early 1990s by MHD power alone

Soviet plans call for gas-burning MHD plants to produce about 10,000 megawatts in the early 1990s. In the United States the present focus is on coal, and the largest existing MHD plant produces only one megawatt of electricity. The difference in scale is due largely to the difficulties of adapting coal to MHD generators, rather than to lagging U.S. development, says Jean Louis, associate director of the energy laboratory at the Massachusetts Institute of Technology.

Jeff Hecht

CONTINUUM

SAFER SURGERY

For certain kinds of high-risk elective (nonemergency) surgery, choose a regional hospital where 200 or more such operations are performed each year and you'll have a better chance of surviving. That is what is suggested, anyway, by a study done by three California researchers.

The death rate in hospitals with more experienced staffs is about one-quarter lower for open-heart surgery, vascular surgery, coronary bypass and prostate-gland surgery than in those hospitals where fewer such operations are carried out.

And the mortality rate in total-hip-replacement operations is about one-third lower in hospitals performing 50 or more each year.

The study, by Dr. Harold S. Luft, of the University of California at San Francisco, and Drs. John P. Bunker and Alain C. Enthoven, of Stanford University, found no relation between the number of operations and the death rates for simpler steps such as gall bladder removal and vagotomy (to control stomach acid in ulcer patients).

Elective surgery gives you time to make a choice, and the safest bet seems to be those hospitals where many operations are performed

The two-year, 840,000-patient study examined the relationship between surgical load and mortality for 12 operations at 1,500 hospitals.

— Alton Blakeslee

"I can accept the theory of relativity as little as I can accept the existence of atoms and other such dogmas."

–Ernst Mach (1838–1916), professor of physics at the University of Vienna

"He needs to stand on tip-toes that hopes to touch the moon."

–Thomas Fuller

PLAY BILL

Last year *Energy User News*, a trade publication, assessed how the national sport – baseball – was interacting with the national preoccupation – energy. The newspaper found little uniformity among baseball clubs. "A few systems were sophisticated by any measure; others could be charitably described as primitive," said Barnaby Feder, who wrote the story. Voluntary conservation programs, he found, worked fitfully. There are all sorts of logistical problems.

The highest electricity bills dog the club that pays the most for almost everything, the New York Yankees. The cost, more than $350,000 a year, the result of high electric rates and a lack of aggressive energy management, the paper found.

The low-energy champion was the Chicago Cubs, who rely on solar power because Wrigley Field has no lights. Total electric cost: $22,000 in 1978.

Some clubs, such as the Philadelphia Phillies, have stadiums with computerized energy-management systems that cut costs by 25 percent. Others, such as the St. Louis Cardinals, still play under inefficient incandescent lights, which must be replaced every year. The club rents the stadium; it wants the owners to finance efficient metal-halide lighting, but the stadium owners want the Cardinals to pay. It's the kind of dispute repeated in many apartment complexes.

After last summer's gasoline crisis, all teams appointed club energy coordinators to upgrade information and systems. As with the rest of us, progress is steady but slow. — S.D.

"Fooling around with alternating current is just a waste of time. Nobody will use it, ever. It's too dangerous. It could kill a man as quick as a bolt of lightning. Direct current is safe."

Thomas Edison to Nikola Tesla

"If you don't rehearse over and over, you're going to be surprised in space. And the surprised man, out there, is the dead one. We get ready, then, by trying to surprise ourselves."

— Ray Bradbury

Cub pitcher winds up in "solar powered" Wrigley Field

CREATING OLD LIFE IN THE LAB

Evidence of life on Earth 3.52 billion years ago, the oldest yet come across, has been found by a group of scientists working on a special project at the University of California at Los Angeles.

Scientists will attempt to simulate Creation in this equipment

Fifteen scientists from five countries are participating in the Precambrian Paleobiology Research Project created by UCLA professor J. William Schopf.

Formed last summer, the group has sent fossil hunters to Canada, Africa and Australia, where the evidence of 3.52 billion-year-old stromatolites (structures formed as a result of a chain-forming bacterial organism) was discovered in a remote mining community ironically named the North Pole. The Australian fossil hunters, directed by Dr. Malcolm Walter, also found the oldest "good" microfossils yet discovered, dated at 2.7 billion years.

We found morphological as well as less reliable chemical evidence of the stromatolites," Dr. Walter said, "and used two isotopic dating methods. So we have a lot of confidence in the date. These sedimentary rocks are fairly well preserved for their age, but it may not be possible to find reliable structural evidence of life older than this, because the rocks deteriorate so much."

Schopf said the project, which will formally end in August 1980, is designed to answer questions "fundamental to everything we know and want to know about life — when and how it came about."

Besides finding and analyzing the oldest Precambrian fossils available, the scientists will attempt to re-create the early earth's atmosphere in the laboratory and chemically age it to simulate changes that would have occurred over billions of years. They will also create and study laboratory models of the atmospheres of other planets.

Allan D. Maurer

"What I like about scientists is that they are a team, so that one need not know their names."

-John Wilmot, Lord of Selmeston, 1895 - 1964

"I don't know what you could say about a day in which you have seen four beautiful sunsets."

John Glenn, February 20, 1962

ASTROSTRUCTURE

Gigantic orbiting "space scrapers" of the future may not be made of metal but of fiberglass, say chemists of Hughes Aircraft Company, in California.

The aerospace firm has developed fiberglass mesh which, when baked by the sun's ultraviolet rays in space, turns into high-strength material, half the weight of aluminum.

The fiberglass is impregnated with a polyester resin which starts out soft and sticky, becoming hard and rigid when basted by the constant blasting of solar radiation. The substance begins hardening within a half hour of exposure and becomes completely firm within six hours.

Engineers believe the fishnetlike material in tubular form can be made into a series of beams, joined to form miles-wide platforms in space. Such structures, built by shuttle construction crews, would constitute future communication and public service satellites, space factories, or perhaps even solar power stations for beaming back energy to Earth.

Hughes is currently building a prototype seven-by three-foot "instant beam" for evaluation by NASA's Marshall Space Flight Center, in Huntsville, Alabama.

Leonard David

"Science is spectrum analysis. Art is photosynthesis."

Karl Kraus

Hughes Aircraft technician stress-tests newly developed fiberglass mesh which hardens when baked by sun's ultraviolet rays

CONTINUUM

NOSTRUM FOR MARE NOSTRUM

Sickness has befallen the Mediterranean Sea, haven for 100 million annual tourists and the backdrop for thousands of years of history. Continual pollution from the 16 countries that border it has turned portions of the huge body of water into foul-smelling, multicolored ecological disasters. "The Mediterranean is dying," the United Nations Environment Programme (UNEP) declared in July 1977.

Now, however, UNEP is slowly securing cooperation among nations that lie about the Mediterranean to halt toxic discharges—both from land and from ships—and to control development to prevent future pollution.

In February 1975, 16 nations first agreed in principle to clean up the sea, which is about a third the size of the United States. Since then, specific plans have been ratified to reduce pollution from ships and planes, and an initial $6.4 million for monitoring and research has been appropriated.

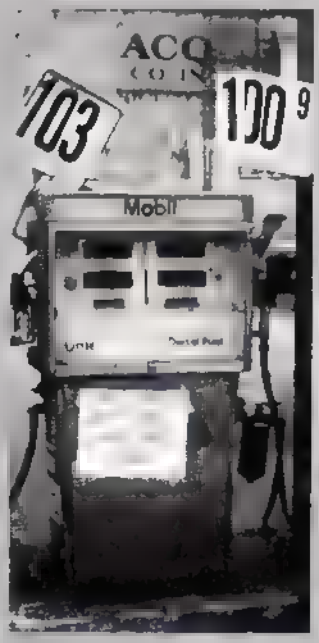
Seventeen nations last June drafted their first agreement to curb land-based pollution such as factory wastes, municipal sewage, and fertilizers. The agreement is expected to be signed in Athens this month.

The overall task is formidable. Ninety percent of the sewage from 120 coastal cities now enters the Mediterranean either untreated or only minimally treated, causing outbreaks of hepatitis, typhoid, and cholera. The sea has been a dumping area for DDT, crude oil, cadmium, lead, copper, mercury, cyanide, and disease-causing bacteria. It is estimated the cleanup will cost at least $10 billion over the next two decades.—S.D.

Idyllic scene illustrates the beauty of the Mediterranean, but DDT, crude oil, and disease-carrying bacteria are ruining the sea

FUELISH HINDSIGHT

The real price of gasoline has not changed in 40 years. In 1941 gasoline cost 19.2 cents per gallon. At the end



A new report gives perspective to modern gas prices

of 1979 gasoline cost only 19.3 cents per gallon—in 1941 dollars, that is, after inflation is taken into account. Last year's actual pump price was about $1 per gallon. Thus, the consumer price index has more than quintupled since 1941.

The U.S. Department of Energy lists these and other tidbits in a recent publication, "Interesting Energy Facts." For example, we find that in 1922 Alexander Graham Bell called alcohol "a beautifully clean and efficient fuel, which can be produced from vegetable matter . . . waste products of our farms and cities."

The first modern internal-combustion engine—the Otto Cycle of 1876—ran on alcohol as well as gasoline. More than a century later we are returning to this concept.

Here are some other energy morsels:

- Coal is not only a fuel. It is a feedstock for perfumes, vitamins, nylon, food preservatives, ink, dynamite, detergents, linoleum, varnish, fertilizer, plastic dolls, and mothballs.
- Eighty pounds of coal, eight gallons of gasoline, and 240 bottles of table wine all hold the same amount of energy—1 million Btu's.
- Americans today, per capita, use four times as much energy as their grandparents' generation did.
- The price of Saudi Arabian oil in 1970 was $1.80 per barrel. Today's price is about $26 per barrel.—S.D.

"It is not at all true that the scientist goes after truth. It goes after him."

Sören Kierkegaard

"Damn the solar system! Bad light, planets too distant, pestered with comets; feeble contrivance, could make a better one myself."

-Lord Francis Jeffrey

"Heaven and Earth were created all together in the same instant, on October 23, 4004 B.C., at nine o'clock in the morning."

John Lightfoot, vice-chancellor of Cambridge University just before the publication of Darwin's Origin of Species

SPERM PERK

Sounds wacky but g ve sperm a caffeine boost and they'l swim twice as fast. The end result, according to an Israeli expert on fert lity, is a higher probabi ty of pregnancy

Dr. Joseph Barkay, of Central Emek Hospital, in Afu a, Israel, art fic.al.y insemi-nated 58 women with five parts semen to one part caf feine There were 10 percent more pregnancies in this group than in a control group of women art fic ally insem - nated with untreated sperm, Happily, babies born to these ' caffeine-treated" women were healthy and showed no chromosomal abnorma ities

Knowing that caffeine nterferes with cell metabolism, sc entists started, in the early 1970s mixing the stimulant w th semen samples. Ear y experiments using bull semen showed that caffeine causes energy to shift out of the sperm body to the ta.like flagella which propels the sperm

Dr Cy Schoenfe d, head of New York School of Med cine s fert ity cl.nic and the f rst person to do test-tube research on caffeine and human sperm, told *Omni*, ' Under the microscope, a perked specimen looks l ke rush-hour crowds in the New York subways An unperked sample looks more like Sunday n the subways "

Dr Schoenfeld has th s to say about his Israeli colleague's work: 'Barkay s experiments clearly show that caffeine helps infertile men whose unfit sperm can't make it to the ovarian tubes, where ferti izat on takes place. would l ke to be doing work along the same

Film scene shows Woody Allen as a decidedly unperked sperm

nes " But, unlike srae , sci entists, American scientists have to do numerous animal tests before doing research on humans

My laboratory simp y doesn t have the resources to do the animal test ng." Schoenfeld says

Caro ne Rob

"To kill a man will be considered as disgusting as we in this day consider it disgusting to eat one."

— Andrew Carnegie, speaking on an end to war in the twentieth century (1900)

NATURE TRIVIA

Another nstal ment of eco og cal amusement from the National Wi dlife Federation

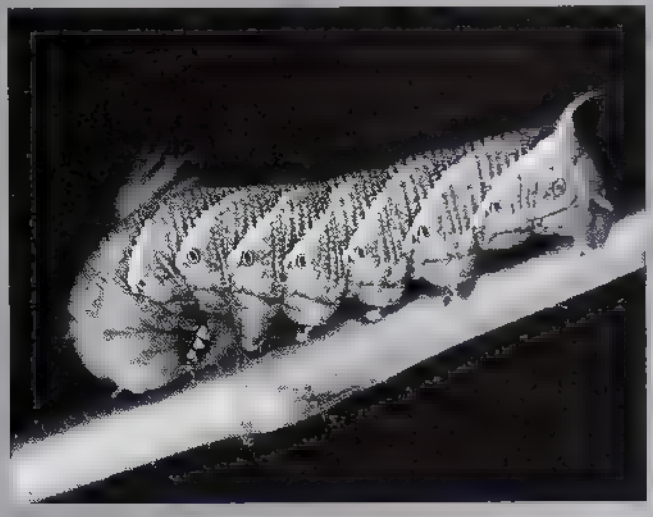
- Marshmal ows weren't always made from sugar and packaged in plastic Once upon a time they were made from the roots of the marsh ma low plant The roots also yie ded a syrup for sore throats, coughs, and burns
- Caterp tars have more muscles than humans The human body has 639 muscles The caterpil ar has more than 4 000 muscles
- More Americans die each year from bee st ngs than from snakebites. In a recent year it was bee st ngs 25 snakebites. 16
- There s truth behind the phrase *leap frog* A full-s zed tree frog can jump 20 times higher than its body length It would be as if an adult human male jumped 120 feet high
- The English sparrow has 14 neck bones tw ce as many as the g raffe
- N nety five percent of all anima s are spineless - iteral y They are inverte brates such as nsects and crustaceans
- Among the world s most careful suitors is the male black widow spider His poison s weak and neffec-tual. f he tries to mate at the wrong time, the female black widow st ngs him to death Or she may first mate w th him, then sting him to death and eat him S D

"Rail travel at high speed is not possible, because passengers, unable to breathe would die of asphyxia

Dr Dionysys Lardner (1793 1859)

"Science originates from curiosity and weak eyes "

Bernard le Bovier de Fontenelle



Behold the muscular caterpillar! While we puny human beings have a mere 639 muscles, the caterp.llar boasts more than 4,000

CONTINUUM

RUNNERS' EDGE

Stock car drivers do it, bicycle racers do it, and so do some speed skaters. Runners *don't* do it, but a new study shows that maybe they ought to.

We're talking about *drafting*, the racing technique of cutting wind drag on a vehicle or person by following closely behind another competitor, be he on a bicycle, on skates, in a car, or on foot.

According to a recent study conducted by Chester R. Kyle, a professor of mechanical engineering at California State University at Long Beach, runners can cut wind resistance over 50 percent by following within five feet of another runner who breasts the wind. Even at ten feet, Kyle says, one can reduce wind drag by 30 percent.

Kyle, in an article in the British journal *Ergonomics*, claims that by using pacers or "rabbits," to shield an eventual winner, the world mile or 1,500-meter record could be broken by several seconds. To do this would require not only the traditional use of rabbits but also exact pacing and precision drafting, which is nearly impossible in open competition.

Even so, Kyle says, "a national team with several world class middle-distance runners should be able to use this tactic with dramatic results."

Runners drafting behind one another reduce wind drag. Used tactically, drafting could trim several seconds off the mile record.

"You will never amount to very much."

A Munich schoolmaster to Albert Einstein, aged ten

FEMALE SUPERIORITY

Genes may be the reason why men are hit with more diseases than women, why men live about eight years less, on average, and why they are more frequent carriers of viruses.

Evolutionary selection has equipped females with immunoregulatory genes on the X chromosome for coping with life-threatening illnesses. Females, who have one more X chromosome than males, are less likely to get some infectious diseases and develop certain forms of cancer. Drs. David T. Purtilo and John L. Sullivan, of Worcester, Massachusetts, write in the *Journal of Diseases of Children*, a publication of the American Medical Association.

A female's greater immunity may be a compensation, they say, for the suppression of her immune defenses during pregnancy — so that the woman does not reject her "foreign" fetus — and so ensures the survival of the pregnant woman and also the survival of the entire species. —A.B.

"Animals, which move, have limbs and muscles. The earth does not have limbs and muscles, therefore it does not move."

Scipio Chiaramonti

THE CHEMISTRY OF OVERWEIGHT

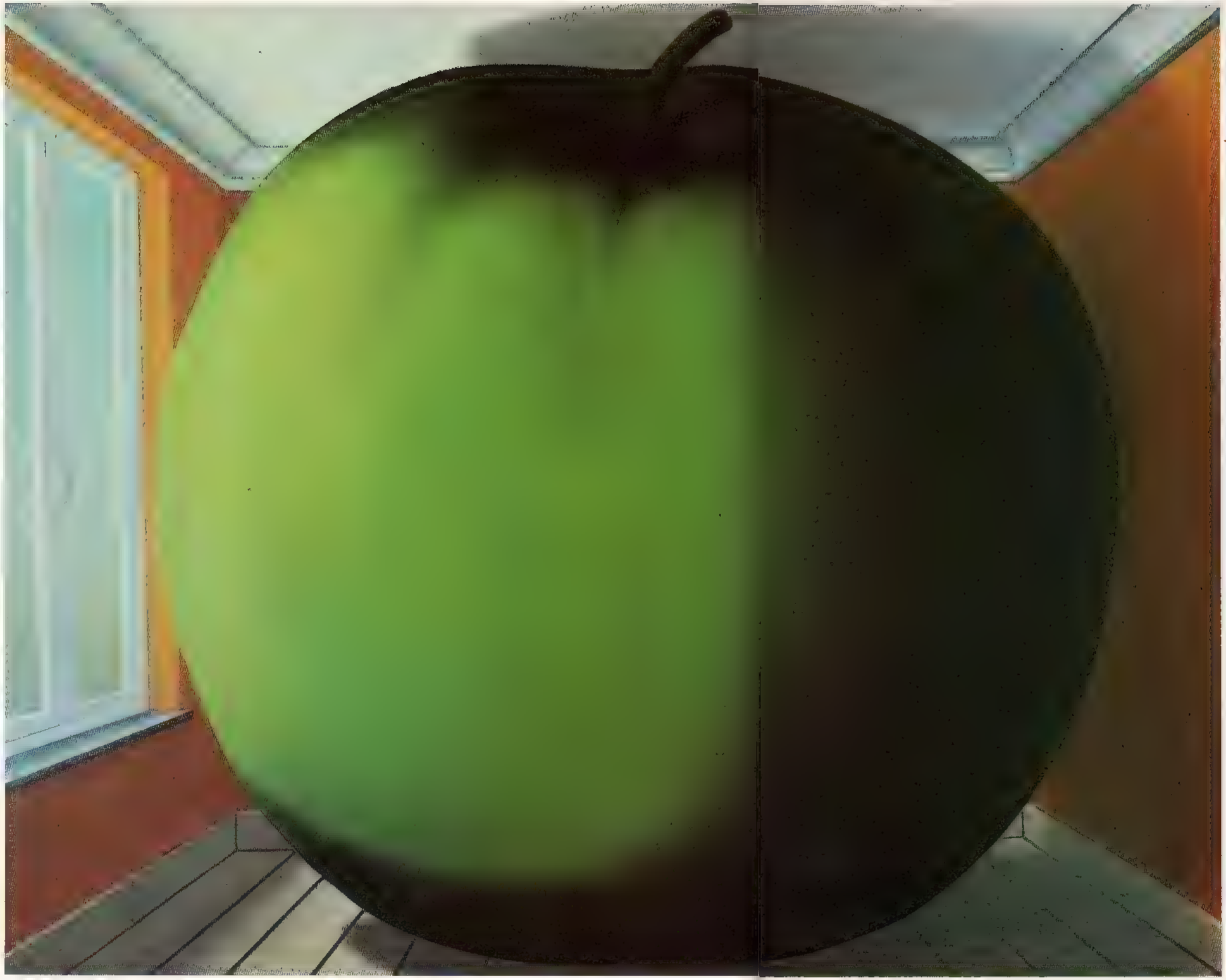
If the extroverted "jolly fat man" loses a lot of weight through a physical fitness program, he's apt to become an introvert, says professor A. H. Ismail, of Purdue University.

A physical education specialist, Dr. Ismail says muscle training can alter the body's biochemistry, and this in turn can produce personality changes, including loss of "fat person's jolliness."

People who are obese tend to be gregarious and to have high cholesterol levels, he says. Dropping pounds through exercise "quite likely" means they will undergo a personality metamorphosis and become introverted.

Persons who tested low in emotional stability before starting Ismail's fitness program became more stable in final tests of personality, the instructor reports. They also showed graphic improvement in serum cholesterol, blood sugar, and blood pressure — all of which became lower, according to Ismail. —A.B.

Exercise can turn extroverted fat people into introverts.



BRAIN WARS

Prime coverage of the nation's "super bowl of tomfoolery"

BY RICHARD CHAPMAN

As the desert sun evaporates the mists off the mountains overlooking Pasadena, California, Caltech seniors disappear from campus. Behind them, in the dim labyrinth of dormitory corridors, underclass "wimps" begin to stir. Night visions of quantum mechanics and chemical reactions still waft through their brains. Breakfast beers in hand, they ramble the halls, discovering the seniors' doors bolted—not just with simple turn-the-key locks or even with complex combinations. These rooms are protected by a startling array of devices rigged to respond to sound, heat, light, magnets, water pressure, computers, or a snake did you say?

From one door emanates a series of electronic boops, beeps, and tweedles—a synthesized musical code to unravel. A fearsome python named Aristotle writhes before another door with clues suggesting his use as a door opener. Some doors, like senior Werner Pyka's, are barred with masses of steel and concrete, but most feature computer terminals, spaghetti mazes of wire tubing, and gadgets that must somehow be manipulated to afford entrance. It's as if Albert Einstein had been reincarnated as a "frat rat." Rube Goldberg meets Luke Skywalker?

It's Ditch Day, an eccentric yearly ritual at Caltech that's an intellectual field day for the young geniuses who pit their

PAINTING BY RENE MAGRITTE

considerable head muscles against one another in a day-long tournament of wit and brawn. These are the technocrazies, the same pack of whiz kids whose stunts have befuddled sober minions of order, ranging from the FBI to giant corporations.

Ditch Day had its origins in some distant, modest prank in which undercassmen broke into the seniors' rooms while the occupants were off on a day of relaxation before final exams. Since then Ditch Day has rumbled its way up the Richter scale (invented at Caltech) to become a major Caltech event for some: it's the highlight of four mind-splitting years of nearly uninterrupted pressure. This "super bowl of tomfoolery" is calculated to give these brilliant students a chance to blow off pre-exam anxiety and to avert a cerebral meltdown.

Ditch Day is governed by an established set of rules and a rigid code of honor. The wimps must follow to the letter any instructions posted on the seniors' doors, and they must gain entrance before the seniors return at 5:00 PM.

The rules list three kinds of "locks or stacks" on the doors. The first, the 'brute force' stack, can be opened by any means short of nuclear weapons. Getting into a brute-force stack, according to one senior who's dealt with several, "requires no intelligence—just some dynamite." A few years ago undercassmen resorted to hydraulic lifts on one brute force stack and raised the room's ceiling to crawl into a senior's room.

The "finesse" stack must be opened by manipulating whatever technological device (electronic, chemical, or biological) is installed on the door. This year an entire room would be transformed into a radio telescope, and every clue would relate to radio astronomy.

The "honor" stack requires wimps to solve a written problem or puzzle before opening the unlocked door. It's claimed that this is the easy way out for lazy seniors, yet several years ago a senior devised a quantum mechanics problem that not only kept out undercassmen but also stymied a Nobel Prize-winning physicist.

The wimps also have a few rules of their own. On Ditch Day any senior caught on campus after 8:00 AM can be abducted and tied to the nearest tree. When the security of a senior's room has finally been breached, either the wimps can accept a "bribe" of food, drink, or other goodies left by the senior in hopes his room will be spared, or they can reengineer the locks or leave unusual surprises of their own. One past "counterstack" was masterminded by a group of wimps who disassembled a senior's sports car, then put it back together in his room, with the engine running. Another year a senior scuba enthusiast returned to his room only to be greeted by a pool of sharks. Last year a senior opened his door and discovered a horse and a cow rummaging through his closet. The designer of that counterstack was senior Tod Lauer, a New Jersey astronomer whose reputation as campus practical joker virtually ensured outrageous acts against his room this year: "I could leave three naked women, Colombian dope, and a bottle of Seagram's, and they'd still counterstack me." Lauer's bribe this year would be a half-eaten cupcake.

At 8:15 A.M. the wimps are massing before Pyka's brute-force stack. A demolitions expert plays around with a mixture of gunpowder and mercury fulminate, while others explore the ventilation ducts and crawl spaces above the room. Another assault force, led by a muscular wimp nicknamed Froggie, attacks the steel plating with crowbars and sledgehammers. Outside, a third group of daredevils has scaled the dorm wall and is testing the windows. A cutting torch is on the way.

Downstairs, the wimps are stumped by Chris Lee's musical door lock, emitting an insistent series of grating tones. After repeated attempts to break the code by serenading the door with a variety of musical instruments, a call goes out for any wimps with perfect pitch.

> *"One year a senior scuba enthusiast returned to his room only to be greeted by a pool of sharks. Another opened his door and found a horse and a cow rummaging through his closet."*

Across campus in Blacker House some underclassmen discover an entire corridor has been stacked. They crowd around a large spring-loaded Plexiglas window revealing a hallway resembling a giant pinball machine festooned with beer bottles, Christmas-tree lights, and *Penthouse* centerfolds. The wimps listen intently to a set of recorded instructions having just been informed the tape will self-destruct.

In an adjoining dorm a small, yet determined, group is already hard at work on what appears to be a simple honor stack. The senior has left five physics problems tacked on his door. Simple enough, yet quite lethal, since these problems can be attacked only after consuming four ounces of bourbon and the box of foul cigars left in front of the door. By 9:00 AM, only one cigar remains, and one wimp lies passed out in the middle of the hallway.

But at Ruddock House the wimps are trying hard to penetrate Stan Cohn's room. It would be a distinct honor, not to mention pleasure, to be the first underclassmen to break into the room of the senior class president. By attacking the dorm's electrical system, the wimps hope to neutralize a sinister silver box guarding Cohn's door. Along the way, they've discovered another bonus that Cohn has left them: a chemistry minilab in which underclassmen are commanded to select several vials and mix various chemicals to obtain further clues. An energetic wimp heads for the bathroom, having just discovered the extent of Cohn's villainy. One of the unmarked vials contains foul-smelling ether—thrown in just for laughs.

SPAWNING GROUND

Anyone who's survived four grueling years at the California Institute of Technology deserves a few laughs. It's a deceptively peaceful and lush campus where some 200 professors and 1,600 students ponder everything from black holes to the basic structure of matter.

Add up the IQ's of the Caltech football team, and the sum exceeds the total number of pounds they weigh. But then Caltech's linemen are not being groomed for the NFL. More likely, they're headed for the *JPL*. Caltech's Jet Propulsion Laboratory, which operates the sophisticated robot spacecraft that are now exploring our solar system.

Tech students also log time at the seismological lab, monitoring creaks and groans in the earth, trying to puzzle out when the Big One is coming—the superquake that will see Californians treading water in the Pacific Ocean.

Caltech astronomers scan the night skies with their telescopes, including the 500-ton giant at Palomar—gathering light from quasars and exploding galaxies. With awesome responsibilities like these, it's easy to see why Techies aren't out on Saturday nights simulating the fall of Rome in writhing flesh piles.

Caltech's academic demands and its incredibly tough workload make MIT look like a trade school. Despite *average* national college entrance-exam scores in the ninety-ninth percentile for math and the ninety-seventh percentile for verbal skills, 30 percent of entering undergraduates never do graduate. Caltech is the toughest school in the nation. It is a boot camp for genius, the spawning ground for many leaders of government and industry who can speak the arcane language of science. The coolly efficient Harold Brown, secretary of Defense, is a former Caltech president, and Frank Press, presidential science adviser, once headed Caltech's seismological laboratory.

BREAKTHROUGH

By midmorning, mounds of sand pour into the hall from Pyka's room. The tenacious wimps crowbar their way through the first steel plating, shoveling out the sandbagged surprise, and are well into the second layer. They know it'll be only a few more minutes before they punch through the sets of railroad ties and get into the

room Brute force sn ckers a sledgehammer ng sophomore " . t s a piece of cake

Several exc ted students enter Blacker House under an archway with this sc pted motto "Doest thou love fe then do not squander t me " Ins de a b g group wastes no time in attack ng the stacked ha way A wimp standing at the Plex glas window carefu y aims a aser dev ce d rect y at one nipp e of a *Penthouse* centerfold "We're sure there's a laser detector up there," he shouts

Across the courtyard, up several sets of crumbling stairs and along a rabb t warren maze of hallways, one of the day's first finesse stacks has been conquered But the v ctors are nowhere to be seen. Only the vict m—an e ectronic glass contrapt on several feet high, which a sober-faced w mp explains is a computerized pot smoker—is st ll on the scene. The stack s mathematical c ues produced an equat on stating the magic number of tokes necessary to open the door Following the honor code undeviat ng y, the underc assmen had been requ red to smoke 27 units of grass The w mps explained that each h t of fully nhaled weed was counted by th s 'tokometer' when the puff nterrupted a ght beam n the tube After 128 hits the device automat ca y re eased the door s lock The empty bagg e at the base of the tube was mute testimony to their accomplishment but the five w mps who d d it were not avai able for comment They were ast seen in the vicinity of the cafeteria

CALTR CKERY

The city of Pasadena breathes a munic pal sigh of re ief on D tch Day t means at least 24 hours of peace for Pasadenans A bastion of conservatism Pasadena's the kind of p ace where General George Patton wou d've ret red to cultivate roses Hav ng Ca tech in its midst can be a t tle unnerv ng for this sta d comm n ty t's as if the be hemoth g ttering mother ship from *Close Encounters* had set down in a sea of we l-manicured awns And the locals have never been qu te sure how to deal with it, especially when th ngs beg n getting out of hand

Besides annoy ng the neighbors with an occasional good-natured prank, the students frequent y engage in com c duels with the harried Pasadena police who by now are thoroughly conv nced that Ca tech students can zip nto other d mens ons at will. Th s seems to be the on y explanat on (bes des marsh gas) for some of the amaz ing student capers

Techies once surrept t ously hau ed a full sized F 84 jet fighter on display at Caltech through three m les of downtown streets to install t on the awn of the ROTC commandant's home

Giant signs, cannons, and sc p tures routinely van sh from their rightful locat ons only to appear in the courtyards of Caltech dorms. Entire y or ginal decorations occasiona y mater al ze n the most unexpected of places When a newly constructed aud torium resembling an ornate wedd ng cake was to be dedicated on camp s a huge bride and groom appeared atop t gazing serene y down at the assembled d gn tar es and crusty patrons who'd paid for the bu d ng A gigant c M ckey Mouse complete with hands, sprouted on the ma n Ca tech clock tower another year

A Caltech prank could ead to a sc ent fic breakthrough, or t m ght just have some fun w th nat ona security It was rumored one year that students were tapping phone l nes and an FBI agent showed up to check it out routinely

"Someone claims you've been tapp ng the professors phones " the agent told a student who was a prime suspect as the culpr t

Oh no, not the professors phones," the student rep ed. "I tapped the Strategic Air Command hot line

For the next two hours the student pleasant y exp ained how he'd tapped nto the SAC s hot ne from a nearby air force base to the Pentagon The student was warned not to attempt any further shenanigans and the shaken agent emerged to phone his superiors It was later reported that sig n f cant changes had been qu ck y made in the SAC commun cat ons system

f they cou d get to the a r force, another group of e ectron c zan es from Caltech reasoned, then they were ready for a tougher foe McDona d's When the hamburger cha n ran a promotional contest n Ca forn a a few years ago Ca tech stu dents exp o ted a oophole in the ru es and gimned up the r computer to crank out 1 2 mill on entr es, b k ng Ronald McDonald

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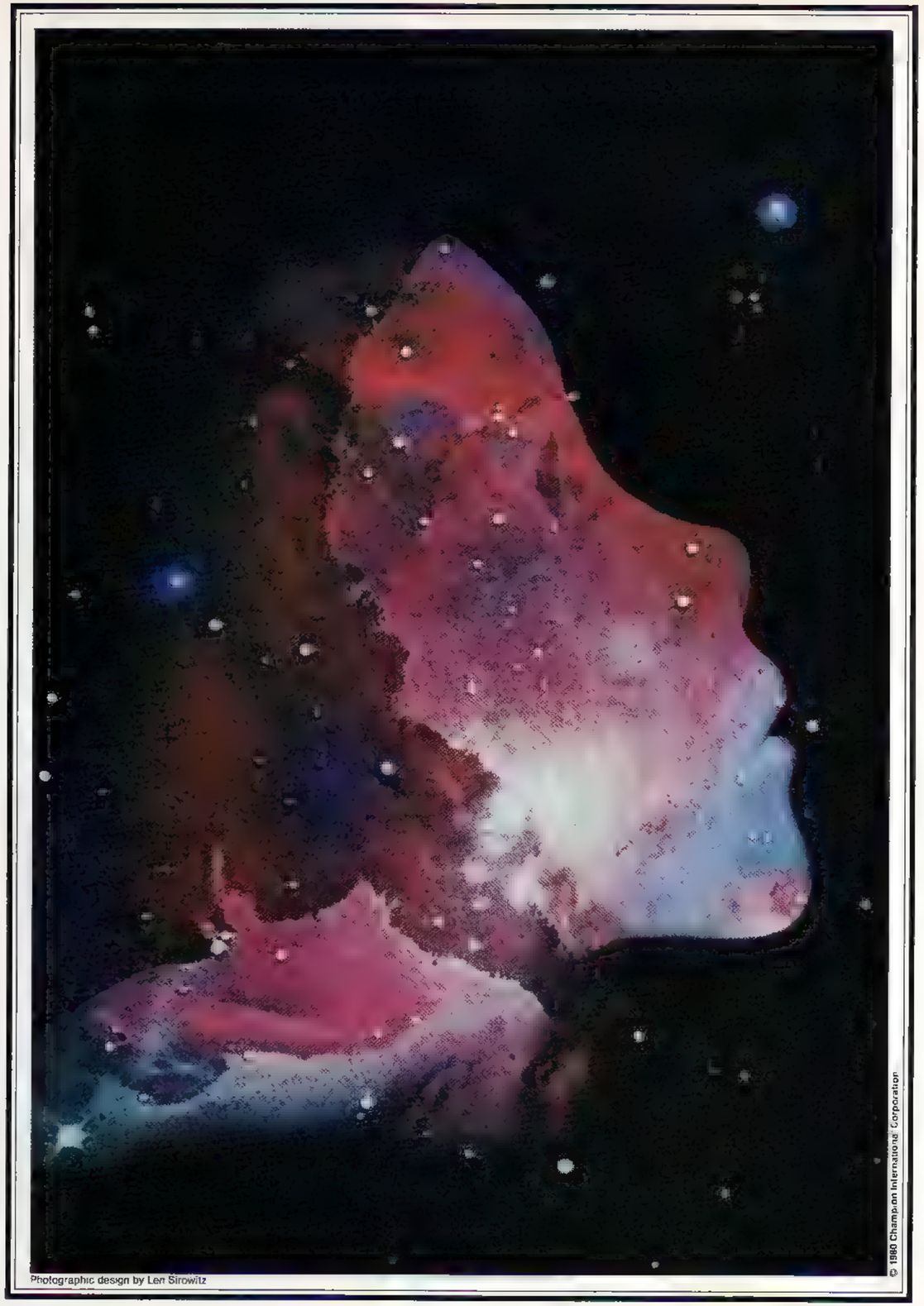

Photographic design by Len Sirowitz

The future is coming. And with it will come great benefits for mankind. And a whole new set of problems. Because we are a forest products company, and plant seeds that take up to 50 years to become mature trees, Champion International has to think a lot about the future. We'd like to share some of the things we've learned with you—to help you make intelligent choices in the years to come. Here is something you might want to think about.

In the future, we may discover that we are not alone in the universe, and we may even make contact with powerful beings from another world.

How might that awesome possibility affect our view of ourselves and our world?

There are trillions upon trillions of stars in the universe. It is a cosmic light show of unimaginable wattage, and it is getting harder and harder to believe that we are the only spectators.

Amazing discoveries about our universe are occuring more and more often. Quasars, which radiate more energy than can be accounted for in earthly physics. Black holes, where all the normal laws of nature seem to be repealed. We are even beginning to understand what happened during the *first 90 seconds* in the life of the universe.

While there is as yet no direct evidence of extraterrestrial life, complex organic molecules have been found throughout the universe. Man has landed space probes on only two planets—Mars and Venus—and the vital ingredient water was found on both of them.

Indeed, scientists have already derived a formula which strongly indicates that there must be many, many technological civilizations out there, and there are huge radio-telescopes trained on the skies, listening. So it should not come as a complete surprise if one day an astronomer looks up from a printout and reports that someone just said hello.

The benefits of an exchange of information could be enormous. They might give us short cuts that would save us a few hundred years of Research & Development. They might present us with practical fusion power which, so far, has eluded earth's scientists. (It could solve the energy shortage in a flash.) Is cancer universal? Progress report, please. And the cold? Is it really common?

There will also be a few problems. How will earthly religions handle the new facts? How will we manage to get along with an alien race that has a different culture, ethics, habits, expectations, rituals, and maybe even four arms, when sometimes we even have trouble getting along with the couple next door, not to mention other nations.

On the other hand, maybe these differences will teach us something fundamentally enlightening about differences, and we'll end up getting along better with each other here on earth. Just that would literally be a gift from the heavens.

But the greatest fact of all will be the demonstration that highly technological societies more advanced than ours *exist*. Have *lasted*. In other words, if they've managed to keep from destroying themselves, maybe we can too.

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FICTION

JOSIE AND THE ELEVATOR

Spoiled rotten and prone to temper tantrums, she was asking for a trip to the ground floor

BY THOMAS M. DISCH

You shouldn't do that, said the elevator, closing its doors on Josie's face and keeping her fast within its cage, for it meant to teach her a lesson. "You can't be going to fourteen *and* to fifteen, especially if you're getting out here on thirteen. You're simply causing *me* to do extra work, and I don't like it."

It waited for the little girl to speak and, when she wouldn't, prodded her. "Well? Speak up."

"Elevators aren't supposed to talk," said Josie, without seeming confounded, only a bit surprised. After all she'd often been in elevators that played music.

"Never mind *supposed*. I demand an apology and a promise that you'll stop punching all my buttons every time you leave. You've been doing that for weeks. Don't think I haven't noticed. It's wrong, and it must stop."

Josie made no reply. She simply stared up at the numbers over the door, none of which was it. Then, pausing a moment to think, she jabbed the button for the first floor.

Don't bother pressing buttons, young lady. I'm not letting you out of here until you apologize politely."

Josie pushed the alarm. It didn't ring. She pushed it again. Still the elevator wouldn't budge.

"*Why* have you been pushing those buttons, I should like to know."

"It's none of your business why I do anything. You're an elevator, and you should just go up and down. I didn't ask you to talk to me."

"I don't need *your* permission, child. I go where I like, at the pace I like. As that also happens to be where my passengers want to go, there's no conflict. But I can keep *you* here as long as ever I like. So you'd best not be surly. Now answer my question."

"I punched the buttons because I wanted to," said Josie, not at all in an accommodating tone.

"And why did you want to?"

"Because I don't like living in this building! This building stinks!"

"And so you'd take out your resentment on me? And on all the other people who have to wait for me? Do you really think that's fair?"

PAINTING BY KLAUS DIETRICH

"I don't care if it is or it isn't. So there."

'Oh, really?' the elevator replied in a tone partly sarcastic and partly ominous. 'I think it would be well if you were *made* to care."

"I never *asked* to live here, did I?"

You should be glad you do. This is a fine building. It keeps you warm in winter and dry when it rains. Where would you sleep at night if you didn't sleep here? What would you eat for dinner if you didn't have a kitchen to cook in?"

"It's an *awful* building," Josie insisted petulantly. "I *know* what nice buildings are like. You can't fool me. My father lives uptown in a penthouse, and when I'm with him, I have my own bedroom *and* my own bathroom, and the tub isn't old and yellow, and the walls don't have cracks and there aren't any cockroaches, and there's a doorman at the front door who always says 'Good morning, Miss Hardwinter. How are you today?'"

"Those are advantages, surely, but they all cost money. People who can't afford such luxuries must make do with what they can afford. What is the doorman's name?"

"How should I know that? He's only a doorman."

"It sounds like you're just as rude when you live with your father as you are here. What sort of things do you talk about with him?"

"He's usually too busy to talk with me. He's a famous businessman. He had his picture in the newspaper, you know."

"I didn't mean your father. I meant the doorman. What do you talk about with *him*?"

"I don't talk with the doorman!" Josie said indignantly.

"You should. Doormen get very bored sitting about in their uniforms, they'd like some company. They're much like elevators in that regard."

"Poo on doormen, and poo on elevators, too! I want to get *out* of here. Right now."

"Not until you apologize."

"I'll scream."

"No one will hear you."

Josie, who by now was genuinely distraught, began to stamp on the scuffed linoleum-tiled floor, but the elevator was not stirred except to become angrier itself. Josie had never understood that this was the invariable result of her temper tantrums.

True to its word, the elevator did not give in. Even when Josie carried out her threat and screamed and threw herself down on the floor and pounded on it with her fists—even though all that the elevator remained unmoved.

It was then Josie made a most unwise decision. She removed her left shoe and threw it with all the force she could muster at the elevator's mirror. That mirror, up in the corner of the cage, was the elevator's proudest possession. No other elevator (it believed), however superior in other respects, could boast a mirror of such bright distinction. When it shattered, the elevator shivered along the length of its whole cable and then, with a terrible roar, began a wild descent. Down it plummeted, down past the first floor without a stop, and still it fell—ever deeper—down to those dark regions only elevators know how to reach. Down to the very floor of hell, where it opened its doors with a shudder and shouted at the astonished child: "Get out!"

Josie got out.

She didn't realize that she'd been taken to hell, for her surroundings looked nearly the same as the ground-floor lobby of her own apartment building. There was the big aluminum ashtray beside the elevator doors, looking just as it had looked in the world above. Josie didn't notice that it was overflowing with cigarette butts and other refuse, nor did she notice when she went outside upon the street, that all the cars were driven much faster and honked their horns on the least provocation.

Hell, you see, is exactly like the world we all live in, the only difference being that everyone you meet there is completely inconsiderate and rude. Judging by appearances, they are the same people you knew above, but they behave quite differently, which Josie was soon to discover.

> *Josie made a most unwise decision. She took off her left shoe and threw it with all the force she could muster at the elevator's mirror. That mirror . . . was the elevator's proudest possession.*

Naturally, she did not want to go back inside the elevator she had just escaped from, nor did she want to climb twelve flights of stairs. Her father had told her that if she were ever in an emergency, she must call him or go to his apartment, and this must surely count as an emergency. So that's where she decided to go. The problem, however, was how would she get there. Her father lived in another neighborhood far on the other side of town. Though Josie knew how to get there on the number 12 bus, the bus driver wouldn't allow her to board the bus without paying. The fare was fifty cents, and she had spent her last change just an hour ago to buy a Mounds candy bar.

She knew that it would be wrong and shameful to ask passersby to give her the money she needed, all the people on the streets of hell looked crazy or hostile or dangerous.

But how was she to *walk* so far, even supposing she could find the way? Her left shoe, the shoe she had thrown at the mirror, was still inside the elevator.

For a long time she just sat on the curb, trying to cry. People she had discovered will often help you if you are crying. But that was in the world above. In hell no one notices your tears at all. In any case she wasn't able to produce more than a bit of dampness about her eyelids, for the air of hell makes it more difficult to cry.

When looking for one produced no results, Josie decided she must ask a policeman to help her. That is what she'd been told to do if she were ever lost. Slipping off her one shoe and both stockings, she began searching for a policeman, taking care not to step on the shattered glass that covered the sidewalk and the street. At the very first corner she came to she didn't see that the light was about to change from green to red, and she was nearly run over by an enormous white Cadillac. She jumped back just in time, and the driver shouted a dirty word out of the window at her.

Josie scarcely noticed the driver's bad language, however, for she had just cut her foot on a big sliver of glass. Hell is full of nonreturnable bottles which people throw from the windows of their apartments just for the satisfaction of hearing them smash.

It would take much too long and be much too distressing to give a full account of all the sufferings that Josie underwent in hell. Sad to say, she lived there for many years, each one a little more miserable than the year before. It had never been the elevator's intention to leave her there so long, but once Josie had gone off to her father's apartment, the matter was beyond its control. Josie, not wanting to report her disagreement with the elevator to her father, allowed him to suppose that the reason why she'd suddenly appeared at his apartment door barefoot and bleeding was that her mother had locked her out of their apartment as a punishment.

Naturally when Mr. Hardwinter called his ex-wife on the phone and yelled at her, Josie's mother was quite angry with her daughter for telling such a lie and piqued that her husband believed it and yelled at her. The argument became embittered, and Mrs. Hardwinter subsequently quit her job with a life insurance company (there are life insurance companies in hell, just as there are here) and went away across the ocean to the island of Ibiza (yes, hell even has its own version of Ibiza) which she had been threatening to do ever since she and Mr. Hardwinter divorced.

Because of this Josie never had occasion to return to her mother's apartment, which had been sublet to a stranger. And so the elevator couldn't take her back to the world above. (Only the elevator that takes you down to hell can take you up again.) The elevator felt very sorry, but there was nothing it could do until Josie reentered its cage.

Although she knew that her life had sud-

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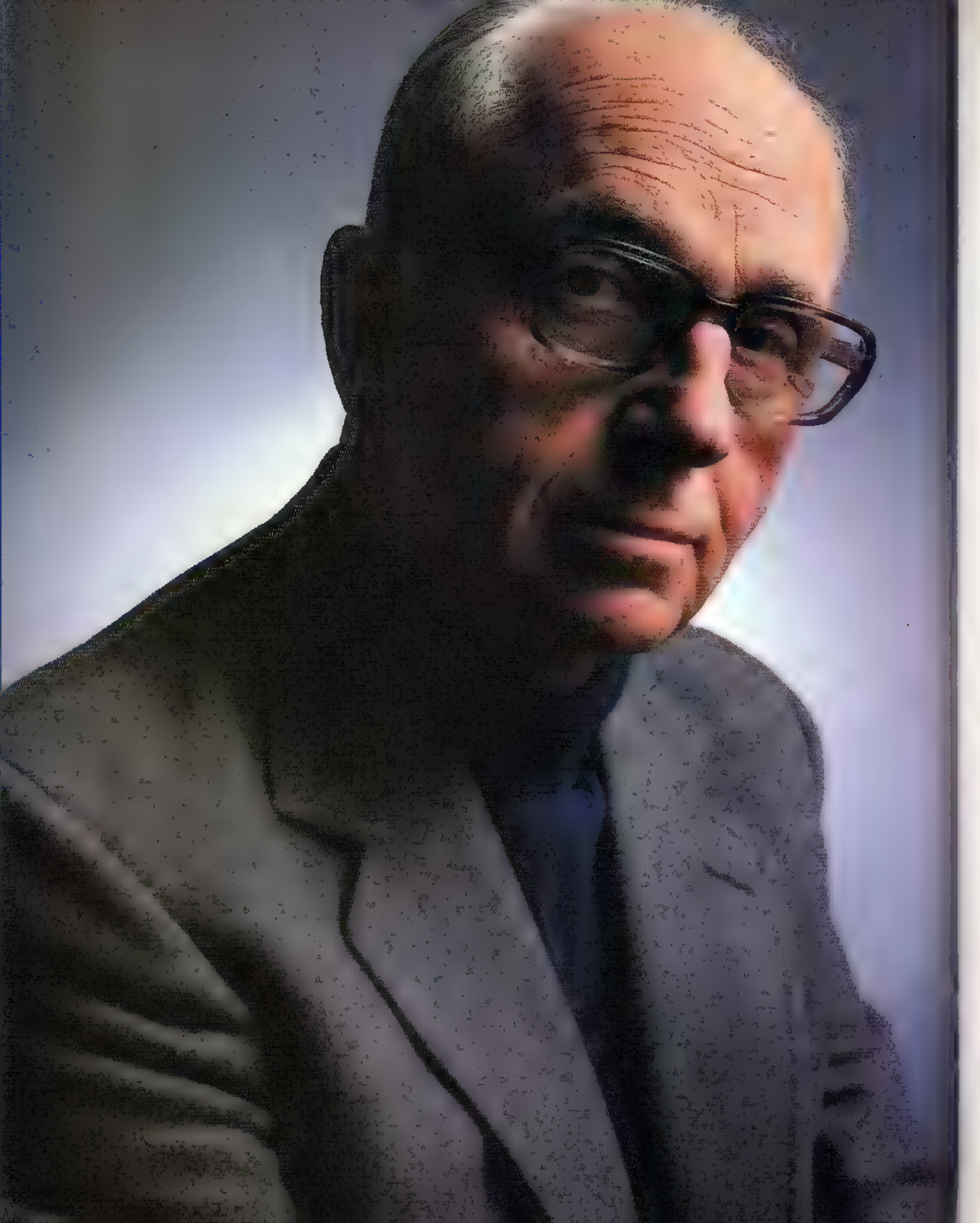

LOOKING TOWARD SPACE

BY JAMES A. MICHENER

A famed novelist decries the lack of a comprehensive American space effort

PHOTOGRAPH BY MICHAEL SOMOROFF

There seem to be great tides that operate in the history of civilization, and nations are prudent if they estimate the force of those tides, their genesis, and the extent to which they can be utilized. A nation that guesses wrong on all its estimates is apt to be in serious trouble, if not on the brink of decline. Filled with speculation, men with clever minds can make remarkable contributions.

Toward the middle of the fifteenth century, nations faced problems comparable to those faced by individuals like Columbus, Vasco da Gama, and Sebastian Cabot. They had to decide whether they wanted to participate in the exploration of the world and, if so, to what degree of commitment. Those nations like Portugal and Spain that made early and fast decisions gained empires of fantastic richness. Others, like disunited Germany and Italy, which did not perceive the possibilities, suffered grave disadvantages and never caught up. England and France were very tardy, but in the end the first made a stunning recovery, the latter never did.

I am not primarily interested in either the exploits of a few daring captains or the economic advantages of the nations they represented. The more lasting effect was on the spirit of the times, that wonderful enlarging of the human consciousness when it realized that the old definitions no longer applied, when it knew that the world consisted of a great deal more than Europe. To have missed the explorations was regrettable, but to have missed this spiritual awakening would have been disastrous. France and Sweden are excellent examples of nations that did little of the manual work but that reaped the intellectual rewards of the period. One might almost argue that Portugal and Spain dragged home the raw material for France and Sweden to codify and digest, proving that any nation can participate in the great swing of civilization according to its peculiar capabilities. Portugal provided daring sea captains. England provided able administrators. France provided the philosophers. Those that provided nothing lost an entire cycle of historical experience, from which they never recovered.

Nor do I think that the rewards resulting from participation in a great cycle need be permanent, reaching down to all generations. I am quite content if my nation gains enlightenment or riches or advantages of other kinds for a respectable period. It can't be the hullabaloo of a single day or week, nor the celebration without foundation of some accidental accomplishment with little subsequent meaning. But if a nation responds to a challenge, succeeds in its effort, garners the rewards for a sensible period, and then loses the commanding position, I think no harm has been done. The nation has gleaned from that experience about all that it was destined to achieve, and a great good has been accomplished, because then the nation is prepared psychologically to tackle the next big problem when it comes along. And it surely will, for the life of any nation since the beginning of history has been a record of how it confronted the great challenges that inevitably came its way.

History is a grand mix of concepts, actions, organizings, and commitments that determines the extent to which any nation can achieve a good life for its citizens, and believe without question that if a nation misses the great movements of its time it misses the foundations on which it can build for the future.

One word of caution. I am not here speaking of either fad or fashion. I am not extolling the attractive ephemeral. And I am certainly not sponsor

A nation that loses its forward thrust is in danger . . . the way to retain it is via exploration.

ing the idea that was so fashionable in the 1930s that German Nazism represented "the wave of the future." Anyone who subscribed to that idea had a very limited view of what the future of the human race could be and few fashionable ideas have ever crumbled so fast and so disastrously. The senate of any nation is obligated to discern the merely fashionable when it offers itself and to reject it.

Suppose that all I have said is true, which would be a miracle equal to those I've been discussing. Where does that leave the United States in relation to its space program? I am competent to comment on only three of its aspects, leaving the more technical details to others.

Are there nonmilitary advantages to be gained from a space program? The high technical requirements for success in space are so fundamental that spinoff rewards are almost automatic. Radio, television, medical instrumentation, miniaturization, watches, new food processes, communications, health advances, and improvement in clothing are some of the few advantages that I myself have gained because of the space program, and I am speaking only of small items that can be comprehended and used by the individual.

If one considers the larger items, such as intercontinental communications satellites, the mapping of weather patterns, the analysis of soils and forests, the exploration for minerals, including oil, the management of fisheries, and the like, the potential rewards are multiplied many times.

I have followed our past space adventures about as carefully as an uninstructed layman could, and I have a rather imaginative mind, but I anticipated almost none of these significant by-products, and I doubt that any of us can predict where the next contributions will be made.

I have heard one impressive argument against what I am saying now. A man of some probity said: "If we had applied our scientific brains to these problems, we could have solved them all at one tenth the cost." He is right. Had Congress 20 years ago set aside a substantial budget and had it authorized the assembling of a body of top scientists, and had it provided them with spacious laboratories and told them: "Devise a computerized navigational instrument that will operate regardless of where in space it is stationed," this could surely have been done. But neither Congress nor the human mind works this way. It is only when great felt needs spur the imagination that certain accomplishments become possible. As a project by itself, few of the bonuses cited above would have materialized, as part of a national effort with a clearly defined goal, they all came into being, and others like them will follow.

Are there military advantages to be gained from a space program? I would be terrified today if only Russian and Chinese vehicles were orbiting in space. Their military advantage would be so tremendous that we might almost suffer as a nation a kind of psychological shock from which we might never recover, for we would certainly be at their mercy.

I fear that potentials of space warfare have yet to be impressed upon the American public. We do not realize the overwhelming advantage a nation would enjoy if it alone commandeered space, if it alone could direct by radio beam when and where an object or its cargo were to be brought down to Earth. Any nation that allowed its enemies such a superiority would soon find itself doomed.

But if all nations have the capacity to utilize space defensively, then the peril is diminished and reasonable arrangements can be worked out. But only through parity can we fully succeed in this endeavor.

Therefore, the United States must have a sensible space program, whether it wants one or not. To fail to keep up with new developments in this field would be disastrous, and any presidential administration that permitted a lag should be resoundingly condemned. We have to know what the capabilities of space are, and we have got to retain our proficiency in using them.

Are there spiritual advantages to be gained from a space program? The spirit of man and the resolve of a nation are tenuous things, to be fortified by the strangest experiences or destroyed by the most unanticipated accidents. Outward events influence them, but inner resolves usually determine outcomes. A novelist sees men and women destroy themselves because the will to survive has been lost; a historian watches nations go down because of fatal wrong choices that sap the national energy. Usually the tragedy occurs when inner convictions are lost or when a sense of frustration or waning purpose prevails.

It is extremely difficult to keep a human life or the life of a nation moving forward with enough energy and commitment to lift it into the next cycle of experience. My own life has been spent chronicling the rise and fall of human systems, and I am convinced that we are all terribly vulnerable.

I do not for a moment believe that the spiritual well-being of our nation depends primarily upon a successful space program. There are, as William James said, moral equivalents to war, moral substitutes for any charismatic national experience. I am sure we could, as a nation, attain great spiritual reassurance from rebuilding our cities or distributing our farm produce better. And my experience in the arts has taught me to be suspicious of late fashions or high styles. Space programs are stylish

CONTINUED ON PAGE 121

FICTION

Only three stood between the world and the threat of another nuclear holocaust

MEN LIKE US

BY DAVID DRAKE

There was a toad crucified against them at the head of the pass. Decades of cooking in the blue haze from the east had left it withered but incorruptible. It remained, even now that the haze was only a memory. The three travelers squatted down before the talisman and stared back at it.

"The village can't be far from here," Smith said at last. "I'll go down tomorrow."

Ssu-ma shrugged and argued, "Why waste time? We can all go down together."

"Time we've got," said Kozinski, playing absently with his ribs as he eyed the toad. "A lot of the stories we've been told come from ignorance, from fear. There may be no more truth to this one than to many of the others. We have a duty, but we have a duty as well not to disrupt needlessly. We'll wait for you and watch."

Smith chuckled wryly. "What sort of men would there be in the world," he said, "if it weren't for men like us?"

All three of them laughed, but no one bothered to finish their old joke.

The trail was steep and narrow. The stream was now bubbling ten meters below, but in springtime it would fill its sharp gorge with a torrent as cold as the snows that spawned it. Coming down the valley, Smith had a good view of Moseby when he had eased around the last facet of rock above the town. It sprawled in the angle of the creek and the river into which the creek plunged. In a niche across the creek from the houses was a broad stone building, lighted by slit windows at second story level. Its only entrance was an armored door. The building could have been a prison or a fortress were it not for the power lines.

PAINTING BY
CLIFF McREYNOLDS

running from it, mostly to the smelter at the riverside. A plume of vapor overhung its slate roof.

One of the pair of guards at the door of the power plant was morosely surveying the opposite side of the gorge for want of anything better to do. He was the first to notice Smith. His jaw dropped. The traveler waved to him. The guard blurted something to his companion and threw a switch beside the door.

What happened then frightened Smith as he thought nothing in the world could frighten him again. An air raid siren on the roof of the power plant sounded, rising into a wail that shook echoes from the gorge. Men and women darted into the streets, some of them armed, but Smith did not see the people. These people, and he did not fear anything they could do to him.

Then the traveler's mind was back in the present, a smile on his face and nothing in his hands but an oak staff worn by the miles of earth and rock it had butted against. He continued down into the village, past the fences and latrines of the nearest of the houses. Men with crossbows met him there, but they did not touch him, only motioned the traveler onward. The rest of the townsfolk gathered in an open area in the center of the town. It separated the detached houses on the east side from the row of flimsier structures built along the river. The latter obviously served as barracks, taverns, and brothels for bargees and smelter workers. The row buildings had no windows facing east, and even their latrines must have been dug on the river side. A few people joined the crowd from them and from the smelter itself, but only a few.

"That's close enough," said the foremost of those awaiting the traveler. The local was a big man with a pink scalp. It shone through the long wisps of white hair that he brushed carefully back over it. His jacket and trousers were of wool, dyed blue so that they nearly matched the shirt of ancient polyester he wore underneath. "Where have you come from?"

"Just about everywhere, one time or another," Smith answered with an engaging grin. "Dubuque, originally, but that was a long time ago."

"Don't play games with the chief," hissed a somewhat younger man with a cruel face and a similar uniform. "You came over the mountains, and *nobody* comes from the Hot Lands."

Chief of police, Smith marveled as he connected the title and the shirts now worn as regalia. Aloud he said, "When's the last time anybody from here walked over the mountains? Ever?"

Bearded faces went hard. The traveler continued, "A hundred years ago, two hundred. It was too hot for you to go anywhere that side of the hills, but not now. Maybe I never sired children of my own, but I never needed that. I needed to see the world, and I have done that, friends."

"Strip him," the chief said flatly.

Smith did not wait for the grim-looking men to force him. He shrugged off his pack and handed it to the nearest of the guards, armed with crossbows and hand-forged swords. He said, "Gently with it, friend. There's some of it that's fragile, and I need it to trade for room and board the next while." He began to unhook his leather vest.

Six of the men besides the chief wore the remnants of police uniforms over their jackets. They were older—not lean warriors like the crossbowmen—but they carried firearms. Five of them had M16 rifles. The anodized finish of the receivers had been polished down to the aluminum by ages of diligent ignorance. The sixth man had a disposable rocket launcher, certain proof that the villagers here had at some time looted an army base—or a guardroom.

Just a boy from the Midwest, Smith continued pleasantly, pulling out the tails of his wooden shirt. "I wanted to see New York City, can you believe that? But we're none of us live forever, will we?"

"What happened then frightened Smith as he thought nothing in the world could frighten him again: An air raid siren . . . sounded, rising into a wail that shook echoes from the gorge."

He laid the shirt folded from habit, on his vest and began unlacing his boots of caribou leather. "There's a crater there now, and the waves still glow blue if there's even an overcast to dim the sun. And your skin prickles."

The traveler grinned. "You won't go there, and I won't go there again, but I've seen it, where the observation deck of the World Trade Towers was just about the closest mortal man got to heaven with his feet on man's earth . . ."

"We've heard the stories," the chief grunted. He carried a stainless-steel revolver in a holster of more recent vintage.

"Trousers?" Smith asked, cocking an eyebrow at the women in dull-colored dresses.

The chief nodded curtly. "When a man comes from the Hot Lands, he has no secrets from us," he said. "Any of us."

"Well, I might do the same in your case," the traveler agreed, tugging loose the laces closing the woolen trousers, "but I can tell you there's little enough truth to the rumors of what walks the wastelands." He pulled the garment down and stepped out of it.

Smith's body was wiry, the muscles tight and thickly covered by hair. If he was unusual at all, it was in that he had been circumcised—no longer a common operation in a world that had better uses for a surgeon's time. Then a woman noticed Smith's left palm, never hidden but somehow never clearly seen until that moment. She screamed and pointed. Others leveled their weapons, buzzing as a hive does when a bear nears it.

Very carefully, his face as blank as the leather of his pack, Smith held his left hand toward the crowd and spread his fingers. Ridges of gnarled flesh stood out as if they had been paraffin refrozen a moment after being liquefied. "Yes, burned it," the traveler said evenly, getting too close to something the something the Blast was too close to. And it'll never heal, no. But it hasn't gotten worse either, and that was years ago. It's not the sort of world where I could complain to have lost so little, hey?"

"Put it down," the chief said abruptly. Then, to the guard who was searching the pack, "Weapons?"

"Only this," the guard said, holding up a sling and a dozen dense pebbles fitted to its leather pocket.

"There's a little folding knife in my pants pocket, Smith volunteered. "I use it to skin the rabbits I take."

"Then put your clothes on," the chief ordered, and the crowd's breath eased. "You can stay at the inn since you've trucked enough to pay for it." He nodded toward the careful pile the guard had made of Smith's trading goods. "and perhaps you can find girls on Front Street to service you as well. There's none of that east of the Assembly here, I warn you. Before you do anything else, though, you talk to me and the boys in private at the station."

The traveler nodded and began dressing without embarrassment.

The police and their guards escorted Smith silently, acting as if they were still uncertain of his status. Their destination was a two-story building of native stone. It had probably been the town hall before the Blast. It was now the chief's residence as well as the government's headquarters. Despite that the building was far less comfortable than many of the newer structures that had been designed to be heated by stoves and lighted by lamps and windows in an office whose plywood paneling had been carefully preserved—despite its shoddy gloominess—the governing oligarchs of the town questioned Smith.

They were probing and businesslike. Smith answered honestly and as fully as he could. Weapons caches? Looted by survivors or rotted in the intervening centuries. Food depots? A myth seeded by memories of supermarkets and brought to flower in the decades of famine and cold that slew ten times as many folk as the Blast had slain directly. Scrap metal for the furnaces? By the millions of tons, but there would be no way to transport it across the mountains. And besides, metals were often hot even at this remove from the Blast.

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"All right," said the chief at last, shutting the handbook of waxed boards on which he had been making notes. The room had become chilly about the time they had had to light the sooty naphtha lamp. "If we think of more during the night, we can ask in the morning." His eyes narrowed. "How long are you expecting to stay?"

Smith shrugged. "A few days. I just like to wander. I really don't have any desire to do anything else." He raised his pack by the straps and added. "Can one of you direct me to your inn?"

Carter, the youngest of the six policemen, stood. He was a blocky man with black hair and a pepper-and-salt beard. He had conducted much of the questioning himself. "I'll take him," he said. Unlike his colleagues, he carried a heavy fighting knife in addition to his automatic rifle. He held the door open for Smith.

The night sky was patchy. When the silver moon was clear there was more light outside than the bud of naphtha cast within. The pall of steam above the power plant bulged and waned like the mantle of an octopus. Tiny azure sparks traced the power lines across the bridge and down into the smelter.

Smith thumbed at the plant. "They made light from electricity, you know? Before the Blast. You ever try that?"

His guide looked at him sharply. "Not like they did. Things glow, but they burn up when we can't keep all the air away from 'em. But you'd be smarter not to ask questions, boy. And maybe you'd be smarter to leave here a little sooner than you planned. Not to be unfriendly, but if you talk to us you'll talk to others. And we don't much care for talk about Moseby. It has a way of spreading where it shouldn't."

The policeman turned through an open gate and up a graveled pathway. Rosy light leaked around the shutters of a large building on the edge of the Assembly. Sound and warm air bloomed into the night when he opened the door. In the mild weather the anteroom door was open within.

"Carter!" shouted a big man at the bar of the taproom. "Just in time to buy us a round." Then he saw Smith and blinked, and the dozen or so men of the company grew quieter than the hiss of the fire.

"Friends, I don't bite," said Smith with a smile. "but I do drink and will sleep. If I can come to an agreement with our host here, that is," he added, beaming toward the barman.

"Moder's the name," said the tall knob-jointed local. Neither he nor the traveler offered to shake hands, but he returned the other's smile with a briefer professional one of his own. "Let's see what you have to trade."

The men at the bar made room as Smith arranged his small stock on the mahogany. First the traveler set out an LP record, still sealed in plastic. Model's lips moved silently as his finger hovered a millimeter above the title. "What's a Cher?" he finally asked.

'The lady's name' said Smith. "She pronounced it 'share.'" Knowing grunts from the men around him chorused the explanation. "You've electricity here, I see. Perhaps there's a phonograph?"

"Naw, and the power's not trained enough yet anyhow," Model said regretfully. His eyes were full of the jacket photograph. "It heats the smelters is all, and—"

"Model, you're supposed to be trading, not running your mouth," the policeman interrupted. "Get on with it."

"Well, if not the record, then," Smith said, "I might make you an offer on the picture—one of the locals broken."

"I won't separate them, I'm afraid," Smith rejoined, "and I won't have the record where it can't be used properly. These may be more useful, though I can't guarantee them after the time they've been sitting . . ." And he laid a red-and-green box of .30-30 cartridges on the wood.

"The chief keeps all the guns in Moseby, besides these," said Carter, patting the plastic stock of his M16. "I'll stay that way. And there's a righteous plenty of ammunition for them already."

"Fine, fine," said Smith, unperturbed, reaching again into his pack. He removed a plastic box that whirred until a tiny green hand reached out of the mechanism to shut itself off. It frightened the onlookers as much as Smith's own radiation scars had. The traveler thoughtfully held the toy again in his pack before taking out his final item, a GI compass.

"It always shows north, unless you're too close to iron," Smith said as he demonstrated. "You can turn the base to any number of degrees and take a sighting through the slot there, but I'll want more than a night's lodging for it."

"Our tokens are good up and down the river," one of the locals suggested, ringing a small brass disk on the bar. It had been struck with a complex pattern of lightning bolts on one side and the number 50 on the other. "You can redeem 'em for iron ingots at dockside,' he explained, thumbing toward the river. 'Course they discount 'em the farther away you get."

"I don't follow rivers a great deal," the traveler led with a smile. "Let's say that I get room and board—and all I care to drink—for a week. . . ."

The chaffering was good-natured and brief, concluding with three days' room and board for—and here Smith nodded toward the stern-faced Carter—so much shorter a time as he actually stayed in the village. In addition, Smith would have all the provisions he requested for his journey and a round for the house now. When Modell took the traveler's hand, extended to seal the bargain, the whole room cheered. The demands for mugs of the sharp, potent beer drew the innkeeper when he would far rather have pored over his pre-Blast acquisition—marvelous, though of scant use to him.

The dealing over, Smith carried his mug to one of the stools before the fire. Sausages, dried vegetables, and a pair of lanterns hung from the roof joists. Deer and elk antlers were pegged to the pine paneling all around the room, and above the mantelpiece glowered the skull of a rat larger than a German shepherd.

"I wonder that a man has the courage to walk alone out there," suggested a heavy-set local who tamped his pipe with the ball of his thumb, "what with the muties and all."

Smith chuckled, swigged his beer, and gestured with the mug at the rat skull. "Like that, you mean? But that's old. The giant rats were nasty enough, I have no doubt, but they weren't any stronger than the wolves, and they were a good deal stupider. Maybe you'd find a colony now and again in ruins downwind of a Strike, but they're not venturers far into the light, and the ones that are left—not many, are nothing that a slingstone or arrow can't cure, if needs be." He paused and smiled. "Besides, their meat's sweet enough, I'm told."

Despite the fire, the other faces in the circle went pale. Smith's eyes registered the reaction while he continued to smile. "Now travelers tell stories, you know," he said, "and there's an art to listening to them. There's little enough to joke about on the trail. So I have to do it here."

His face went serious for a moment, and he added, "But I tell you this and swear to the truth of it. When I was near what may have been Cleveland, I thought I'd caught a mouse rummaging in my pack. And when I fetched it out, it was no bigger than a mouse, and its legs were folded under it so it could hop and scurry the way a mouse can. But its head—there was a horn just there—the traveler touched the tip of his nose—'and another little one just behind it. I figure some zoo keeper before the Blast would have called me a liar if I'd told him what his rhinos would breed to. Don't you think?"

He drank deep. The company buzzed at the wonder and the easy fellowship of the man who had seen it.

"Scottie meant the half-men, didn't you, Scottie?" said a burly man whose mustache and the beard fringing his mouth were dark with beer. He mimed an extra head with his clenched fist. "Monsters like that in the Hot Lands."

Smith's head bobbed sagely against the chorus of grim assent from the other men. "Sure, I know what you mean," he said. "Two-headed men? Girls with an extra pair of legs coming out of their bellies?"

Sounds of horror and agreement.

"You see," the traveler went on, "the Blast changed things, but you know as well as I do that it didn't change them to be easier for men. There've always been children born as . . . monsters, if you will. Maybe more born nowadays than there were before the Blast, but they *were* born, and I've seen books that were old at the Blast that talk of them. And they don't live now, my friends. Life everywhere is too hard, and those poor innocents remind folk of the

CONTINUED ON PAGE 110

FUTURE GENDERS

There are as many sexes as there are people

BY JOHN STOLTENBERG

Just for fun Dr John Money tells his students at Johns Hopkins School of Medicine, "ask yourself Would I take a pill that could change my sex?

ask you that he explains because it s a device to force you to think about your own sexual status your own gender identity and how you really feel about t

Coming from Dr Money the question has extra impact A noted sexologist he s director of the psychohormonal research unit at Johns Hopkins in Baltimore He s also one of the men responsible for the first sex change operation ever performed in the United States And he's convinced that for many practical purposes our gender is a matter of choice, not of genetic chance

There are not two sexes he declares "There is a continuum You can t do a head count It doesn t work that way You don't even come up with fifteen or fifty different sexes t looks like a spectrum

When the Polish astronomer Nicholas Copernicus announced in 1543 that the sun does not revolve around the earth his discovery set off a cataclysm in human consciousness Earth had always revolved around the sun, but people had long believed the reverse Suddenly the entire universe had to be rethought The notion that there are not really two sexes could very well set off just such a shock wave in the near future

Writing in *Woman Hating A*

PAINTING BY WOLFGANG HUTTER

Radical Look at Sexuality in 1974 feminist Andrea Dworkin commented that Money's research into the variability of human sexedness "threatens to transform the traditional biology of sex difference into the radical biology of sex similarity. That is not to say that there is one sex, but that there are many." Dworkin named that condition *multisexuality*. "We are clearly a multisexed species," she asserted.

"'Man' and 'woman' are fictions, caricatures, cultural constructs."

Make a note for the twenty-first century.

Dworkin's reception suits John Money well. He is very much a social activist, a crusader for a change in attitudes. He describes himself as "a skeptic and a rebel against establishment hypotheses." He argues publicly against the "sexual dictatorship" that he believes rules society, and he urges the establishment of a "sexual democracy" in which all sexual nonconformities would be tolerated so long as they do not "cross the dividing line of infringing on the personal inviolacy of the partner."

Money has been a pioneer of sexual medicine throughout his career. He claims to have been the first to use the phrase *gender role* (back in 1955, after which, he says, the concept "took off like wildfire"), and he was largely responsible for the acceptance of transsexualism as a condition suitable for surgical, medical and psychological treatment.

The first sex-change operation in the United States was performed stealthily at Johns Hopkins Hospital one night in February 1965. It was John Money and surgeon Howard W. Jones, Jr., who made the decision to go ahead with the radical operation. Money says the toughest ethical decisions in his career have sprung from the volatile issue of transsexuality.

"I did it, first of all, because I was properly interested in the welfare of transsexuals," Money says. "But also did it because I knew that there was no better way at that moment to establish the legitimacy of sexological medicine and of the change in medical attitude toward people with sexual problems. Surgeons always possess tremendous prestige compared with psychiatrists and psychologists. The operation would force medicine to be far more serious about sexological problems. Indirectly this would compel society to take a different approach toward the people you might call sexual dissidents."

Money is still diligently striving to make people take unfamiliar sexual concepts seriously.

One winter evening I sat in on Money's class "Biosocial Aspects of Human Sexuality," which he teaches for undergraduates. At fifty-eight he cuts a dapper figure in a tweedy jacket and navy-blue tie, electric blue shirt, and hiking boots. There is, perhaps, something of his past life as a schoolteacher in New Zealand (where he was born and reared) in the neat wedge of a mustache and his wire-rim specs. Until recently he wore his gray hair slicked down in straight strands, but now it is modishly curled. He speaks elegantly and eloquently, often in layman's terms, in a gracefully composed manner that he deliberately cultivated when he started teaching. It is an impressive elocution, and he uses it almost all the time.

He clearly relished the adventurousness permitted him here on Johns Hopkins's uptown campus—it is less staid, he finds, than the medical school downtown—and he obviously enjoys astonishing his students. He began his class with a 20-minute excerpt from *High Rise*, a pornographic film from his collection. After it ended he remarked somewhat perfunctorily on the "sexism" and "sexstereotyping" in the film, then asked "How young is too young to be able to see something like that?" Money strongly advocates the use of pornography in children's sexual instruction.

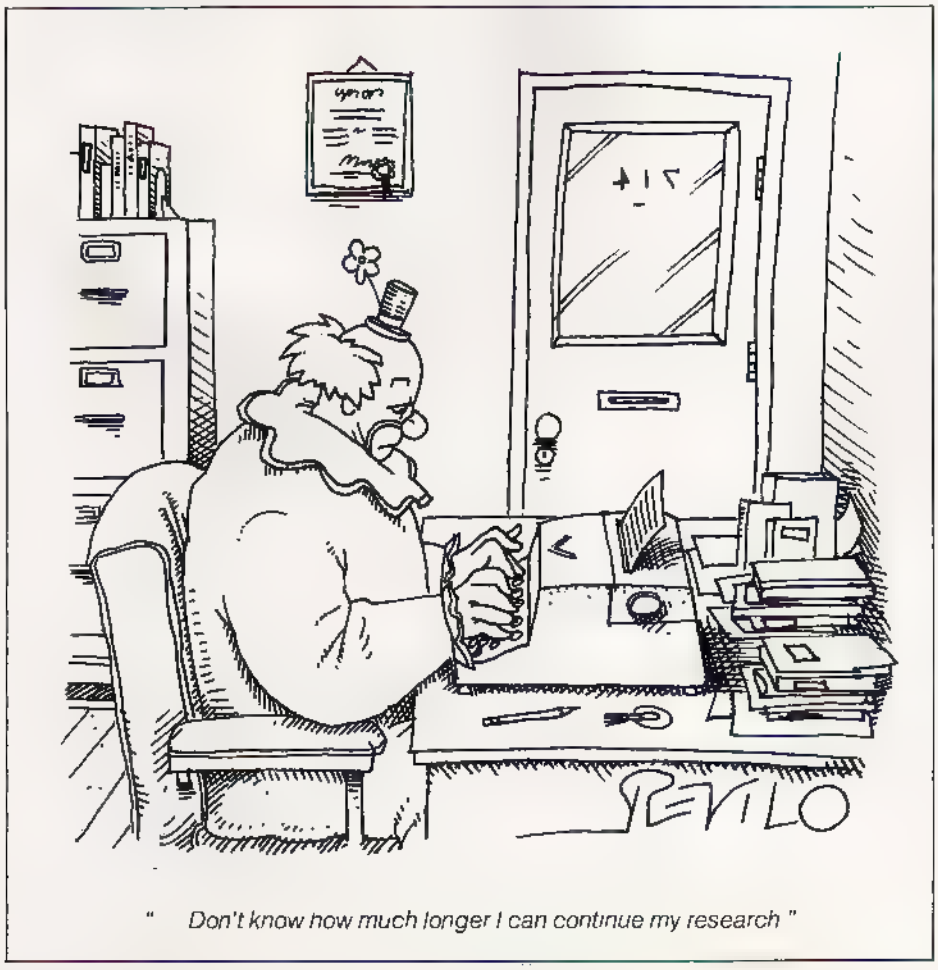
Now the room no longer reverberated with coarse guffaws; rather, there was an edgy kind of curiosity in the class. A montage of slides flashed before the class—bodies dressed and undressed, genitalia in close-ups, faces in smiles, infants, children, and teen-agers.

We saw "a person who got born with a perfectly normal looking penis but who had two ovaries inside." Another picture of two babies' groins showed absolutely identical looking penile-and-scrotal development. "One of these babies is a genetic XX female, and the other one is a genetic XY male," Money says. "You can throw your penny and make your decision which one is which." Another picture displays two other babies' groins that both look like vulvas; again one is XX and one is XY.

Then came a picture of a strapping eleven-year-old boy who is now, we were told, twenty years of age. "He still has XX chromosomes in every cell of his body, and he was born with two ovaries. If it had been discovered before he was a few days or a few weeks old, he could have been rehabilitated surgically and hormonally. By now he could have delivered three or four babies. Such then is the relativity of sex in the way nature designs us as compared with our way of conceiving and conceptualizing what she [nature] may have done."

This "vast range of genital formations," Money explains, occurs because everyone's genitals develop prenatally from the same embryonic tissue under the influence of the hormone androgen. The shape of the genitals depends on how much androgen was present during their formation.

It's a misconception, he says, that there are "male" hormones and "female" hormones and that men have one kind and women the other. In fact everyone has all of them, in countless different proportions. Money likes to tell his undergraduate students that all the young men present have enough estrogen in their bodies to grow breasts were it not that their androgen suppresses that effect, and that all the



"*Don't know how much longer I can continue my research.*"

women have enough androgen in their bodies to grow beards but estrogen is anti-androgenic and inhibits hair growth.

Most people with some knowledge of basic genetics believe that the so-called sex chromosomes determine our gender. Either you are XX (female) or you are XY (male). Money points out, however, that even chromosomal sex is completely variable. "As of this moment," he says, "we can make a fairly good classification scientifically that there are XY men and there are a very, very few XX men; there are XX women and there are a very few XY women. There are X zero women, but there's no Y zero anything because it doesn't live.

"Then there are XXY men and there are XYY men and there are XXX women. And the mosaics. There's XXY/XY some cells having one combination and other cells having the other. I can go on from here until halfway across the room with all of these very rare mosaics that are viable which have very weird combinations of the X and the Y chromosomes.

"There's an even rarer set of conditions in which you have an X and a Y with breakages and cross-linkages and translocations in them. An arm breaks off one chromosome and gets joined onto another and then that one replicates [illegible] all the way across the room with the known cases of that.

"So I can come up with probably several hundred known varieties—esoterically rare—but they have been recorded. And chromosomally there are all that many different kinds of chromosomal sex. And a fair number of them are fertile."

Money's list of sex variables goes on and on. "There are all the different kinds of prenatal hormonal sexual variants—a whole spectrum of how the sex hormones were in balance in the prenatal period. There's what happens to a baby in the birth process that may influence sexual development. There would be many sexes if you chose to use that criterion. There's the bonding of the baby to the mother and the father in the first few hours and days of life. And all the postnatal influences that get in through the eyes and the ears and the skin senses.

"Sex is not determined on the basis of any of its criteria taken alone," Money suggests. "There is no absolute correlation between a person's sex and any particular biological or biographical fact. People are absolute about male and female, [illegible]. Nature is not. Because we're so used to the differences being maximized, we simply fall into a pattern of accepting them. It doesn't occur to us to ask, Well, what would happen if I turned the thing around and looked for similarities?

Some people argue that all the anomalies—the esoterically rare cases of variation in chromosomal sex, for instance, or the babies born with ambiguous genitalia—are merely freaks and mutations. They are the exceptions that prove the two-sex rule. Anomalies, it is said, do

not make human sexedness a continuum.

Money confronts this argument with a story from his days as a graduate student in social relations at Harvard, concentrating in cultural anthropology, sociology, and clinical psychology. He wrote his doctoral dissertation on hermaphrodites and intersexes—people born with somewhere in between sex organs.

During his research he came upon one particularly unusual case: a person who had been considered to be a boy all his life although his penis had been "defective" at birth and had been 'corrected' surgically. The boy's diagnosis was abruptly revised however when at age eleven he began to menstruate through his penis. Only then was it discovered that the "boy" had two normally functioning ovaries and a uterus.

Money's problem was to make statistical sense out of a clinical condition that he had seen only once and that had been reported only six times. He consulted Dr. Frederick Mosteller, a mathematician in the department of social relations and later president of the American Association for the Advancement of Science. The statistician told him, "Well, you've got one case that completely destroys everybody's conception about what can happen to a genetic female. You just need one of them to show that all hypotheses have to be revised."

The exception, in other words, disproves the rule. "The first step in the history of this science," Money continues, "is to say, it can happen once, therefore no theory can stand up until it's been tested against this. Since nobody had ever worked in the psychology and behavioral development of hermaphrodites before, it gave me a field day to turn traditional belief upside down. That's the beginning of a new science, isn't it? To say 'We have to ask some new questions now.'"

Money is not the only sexologist who challenges traditional views. He is not even the most radical.

Dr. Anke Ehrhardt, Money's coauthor on the influential and controversial book *Man & Woman, Boy & Girl*, grew up in Germany and received her doctorate at the University of Dusseldorf. At Johns Hopkins working with Money, she studies children who had received higher-than-normal levels of androgen prenatally, continuing a research project she pursued at the State University of New York at Buffalo.

Even now many of the children she sees are referred to her because of indeterminate genital sex at birth or because of endocrinological departures from the norm. She is deeply concerned about their welfare, growing up in a world where male and female gender identities are rigidly divided and codified. 'A person's gender identity, or primary identification as male or female, seems to be very much dependent on what happens after birth rather than before,' she says. "One's gender identity can be in total contrast to what happened before."

Dr. Ehrhardt often recommends that children be taught a gender identity opposite to their biological sex. If a child is born with XY chromosomal sex and possibly fertile testes but with only a minuscule penis, Ehrhardt is apt to recommend that the child be raised as a girl instead of as a boy.

The reason for this sex reassignment is simple. She has seen tragic consequences when such infants are raised as boys. "They usually go through an absolutely brutal childhood, victimized by their peers. All those issues, like being able to stand up to urinate, are of incredible importance in childhood in our culture."

These boys, she says, grow up beset by self-doubts and lacking any hope of an erotic relationship in which their fertility might be of any use to them, even when—after 10 or 12 operations—they have a reasonable-looking penis. But if they are raised as girls instead—their testicles having been removed at age nine or ten—these young women [do] very well in their sexual response pattern. Typically, they are orgasmic."

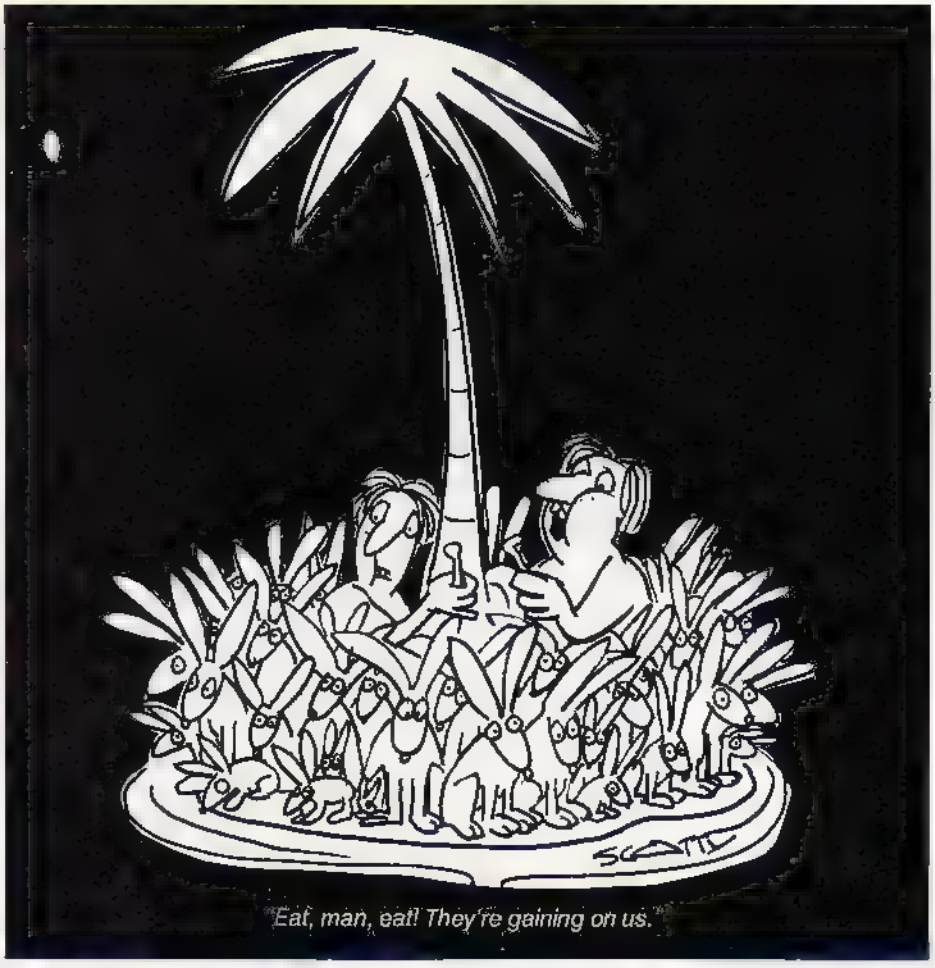
That such individuals become women with normal sexual response patterns raises some intriguing questions. Is there really an anatomical basis for the difference we believe exists between normal male and normal female eroticism? Don't these individuals suggest radical similarity in the erotic potential of so-called men and women? Perhaps. 'The whole perineal area has the potential to be orgasmic,' Ehrhardt says.

She admits that her recommendation that a genetically male infant with a microphallus be raised as a girl flies in the face of conventional wisdom. "It touches on the taboo that these two sexes, these two genders, are predetermined by the reproductive potential. If you go against that, you know you are an absolute rebel."

She sees four very separate areas in which biology might influence human sex differences. Three of them are fluid or continuing categories, where no male-female dichotomy exists. Only one is an either/or gender identity, our belief that we belong to one sex or to the other. Prenatal effects have virtually nothing to do with that belief, it is not immutably linked to any anatomical fact at all.

Second is sex dimorphic behavior, such as temperament or energy level. Ehrhardt's studies show that extra prenatal androgen produces a high level of gross physical energy in childhood. Yet no such behavior is biologically inevitable, nor will it express itself no matter what happens after birth; rather these behavior patterns will occur only if the environment permits.

Third is sexual orientation, the degree to which one is sexually attracted to males or females or both. Ehrhardt doubts that biology influences this at all. The fourth category is cognitive sex differences, particular patterns of cognition such as verbal ability, space form perception, and so on. 'We deal with an overlap among men and



"Eat, man, eat! They're gaining on us."

women in any of these behavior areas, Ehrhardt says, "except in gender identity."

The question arises: What exactly is a sex?" Is there really any such thing? After all, gender identity does not correlate with any single biological variable, not even with reproductive capability. If there are people whose belief about their "sex" completely contradicts every biological variable by which a sex is conventionally defined (including reproductive capability), then we seem to be faced with those remarkable exceptions that disprove all old rules. We will need a whole new theory to explain things. So far we don't have it.

Where does this leave us? "There is no absolute dichotomy of male and female even with respect to chromosomal and gonadal sex," Money teaches us. Yet asked whether science has any responsibility to help bring people's absolutist ideas about gender dichotomy more into harmony with nature's vast variability, he answers evasively. "Well, don't forget that people are nature. Nature designed us to have a way of approaching things in our thoughts in terms of laws of nature and moral absolutes and that's in itself a fact of nature, isn't it?" That translates, roughly: "People may not be created male or female, but they are created to think of themselves as male or female. Perhaps science should leave well enough alone."

So why are so few people interested in diversity, though nature is?

"Oh, it's easier to process your thoughts when you make them all come into focus on one thing," Money says. "It's like the good paranoid. You know, one explanation covers everything."

Money has written that it doesn't matter what differences there are between male and female in human culture, what matters is only that reproductive and coital functions be clear and decisive. "It doesn't matter whether Daddy makes the pancakes and Mommy drives the tractor, just so long as the kid knows, from as far back as he ever remembers, that only women carry pregnancies and only men put their penises in. And if you know what your penis or your vulva and vagina are for, then you don't have to bother a damn about how you earn your living or where you enjoy your recreation."

Coming from someone who has declared the utter relativity of human gender, it seems an oddly orthodox view. One gets the feeling that John Money is a pathfinder who will never really live in the land he discovered.

Some critics have indeed suggested that the medical establishment to which Money belongs, serves to reinforce the false separation between male and female, particularly by promoting the "treatable syndrome" of transsexualism. Foremost among those critics is Dr. Janice Raymond, assistant professor of women's studies and medical ethics at Hampshire College and the University of Massachusetts, in Amherst.

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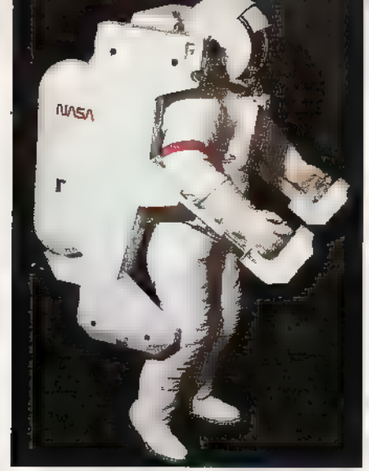


Giants of aerospace are gathering to show us our future

GT 2000

BY KENNETH JON ROSE

The future sweeps in at an accelerating pace. Science and technology touch every aspect of our lives, changing everything they touch. Astronauts place humanity's footprints on the dusty surface of the moon. Surgeons save lives with lasers, microminiaturized instruments and prosthetic organs. Fingertip-sized computers revolutionize information processing. Bioengineers tailor bacteria to produce human insulin and interferon.

"Ninety-five percent of America's new technology will be developed for transportation, energy, space science and defense," predicts Jerry Grey, director of public policy for the American Institute of Aeronautics and Astronautics (AIAA). This prestigious aggregate of engineers annually sponsors a Technical Display, which this year will be open to the public for the first time.

Global Technology 2000, as it's been designated, may be the most ambitious display of aerospace technology in U.S.

Left: Tentlike "tension structures" glow in the Florida night at Sea World, near Orlando. These lightweight, energy-efficient buildings have skins of Owens-Corning Fiberglas coated with DuPont Teflon. Top: NASA's Manned Maneuvering Unit, developed by Martin Marietta, will propel weightless astronauts with jets of gas.

Right. Forward-swept wings on Grumman's future flyer promise increased maneuver ability and fuel efficiency, decreased weight and cost Above Westinghouse's "people mover" at Tampa Airport is a forerunner of tomorrow's mass transit Top left. Goodyear's proposed "heavy lifter" hoists 75-ton payloads with helium and four helicopter rotors Top right. ETV-1, an experimental electric vehicle, was built by General Electric, Chrysler, and Globe-Union to promote no-gas buggies

"Downtown air buses will land on top of buildings or enter through openings in the side."

history. Its general chairman, Laurence Adams, president of Martin Marietta Aerospace views the industrial exhibition as nothing short of a milestone in the history of modern technology.

"Technology is where the world's future lies, and GT 2000 will show what we're doing about it," he declares. Everything from glittering satellites to wind turbines will be exhibited, as well as scaled-down jets rockets future space shuttles lasers, computers, and solar cells.

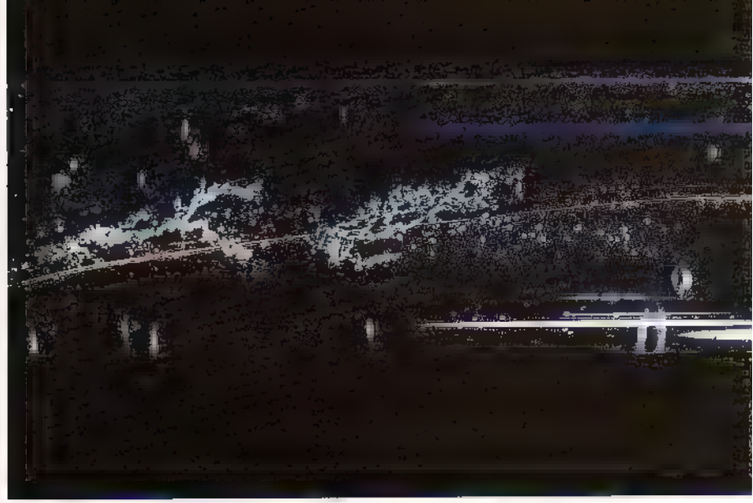
The display, part of AIAA's international annual meeting, is being held May 9 to 11 at the new Convention Center in Baltimore's downtown inner-harbor area only a few miles from the National Air and Space Museum, in Washington, D.C. The museum houses the largest permanent display of aerospace technology in the world.

Inside the five-acre structure—and spilling out onto the parks and

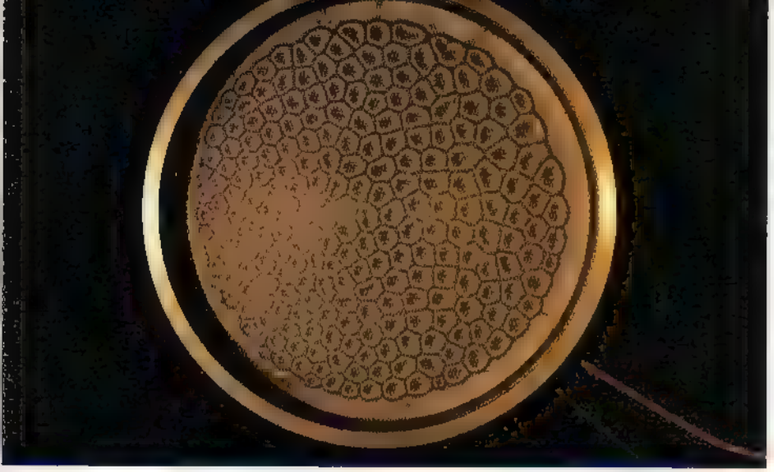
"The important thing is that technology, no matter how good, how promising it is, takes time."

harbor nearby—companies like General Electric, IBM, Westinghouse, Hughes Aircraft, Aérospatiale, Fokker and others will be showing off their latest wares. From the look of it, a good deal of the world's technological future will be on exhibit. Rockwell has reserved space for its mock-ups of the space shuttle. Lockheed will display images of the robotlike Mars rover and models of hydrogen-fueled planes, which may someday transport passengers nonstop across the Pacific faster than ever before. IBM's newest computers will be well represented, and Ford Aerospace will display its most advanced Intelsat telephone relay satellites. Intelsat 5 is now being used by 103 nations.

Among the gleaming communications satellites of Hughes Aircraft and COMSAT, the TRW company will exhibit everything from megalithic solar arrays to fusion equipment, which might someday take energy



Left: Four-footed "autonomous rover," developed by NASA's Jet Propulsion Laboratory, at Pasadena, roams rough planetary terrain. Top left: Glowing blue in the earth's atmosphere, an electric ion-propulsion engine, built by Hughes for NASA, warms up for a mission to intercept Halley's Comet. Top right: Silver crystals, grown in space by Lockheed, may improve earthly industrial processes. Above: Martin Marietta's "expanding space structures" produce big things from small packages.

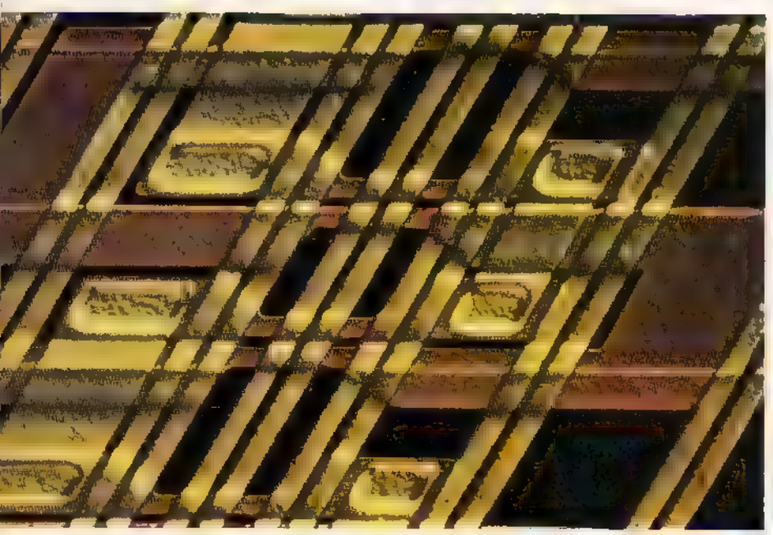


"The world's future is technology; GT 2000 will show what we're doing about it."

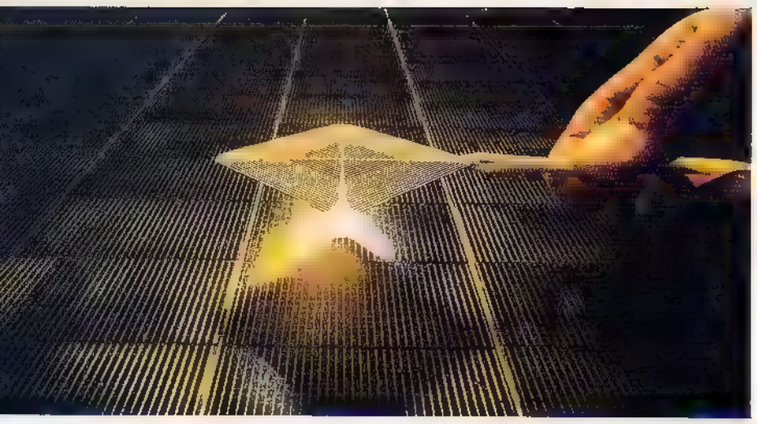
from the sea. "This is the public's opportunity," says Lawrence Craner, AIAA's director of displays, "to peek into the future as it is perceived by the world's leading practitioners of research and development."

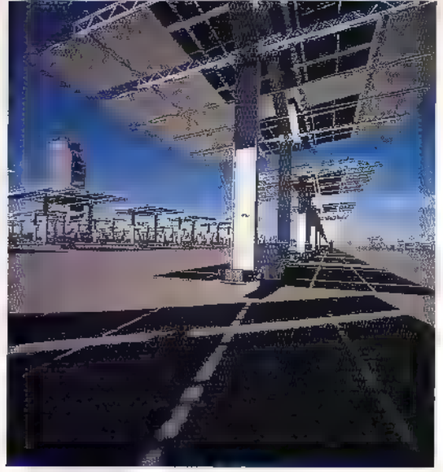
For Edgar Cortright, president of Lockheed-California Company, Craner's statement is especially true. The Lockheed executive forecasts an impressive future for air transportation: "I believe we will see intracity and intercity vertical takeoff aircraft that might follow along railroad lines as their right of way . . . commuter type air buses that would fly downtown and either land on top of buildings or fly into openings in the sides of vertical terminals."

Communications, Burton Edelson at COMSAT predicts, will loom even larger as satellites increase in size and power output. Soon, perhaps before the century is out, receiving stations on Earth might be



Right: Grumman's beam builder extrudes aluminum members for space constructions. Above: Magnetic bubbles on an IBM lattice store 5 million bits of information per square inch. Top left: Performed aboard Skylab, Lockheed's experiment on cellular convection in zero gravity will aid future high technologies. Top right: Hughes's 14-foot-diameter LEASAT makes maximum use of the space shuttle's 15-foot cargo bay. Beginning in 1982, LEASATs will ring the earth to relay telecommunications.





"By the turn of the century, 5 percent of the power used in the U.S.A. will be solar"

as small as a wristwatch. "The restrictions on satellite communications," he says, "will not be technological. They'll be economic."

No one at GT 2000 really expects to foretell our exact future, bright as their hopes are. "The fact that something exists in concept, so that one can build a model or prototype today, does not make it currently usable technology," cautions Alexander Flax, president of the Institute of Defense Analysis, in Virginia. And Fred Koomanoff, director of the Department of Energy's satellite power systems project division, says: "The important thing for people to understand is that technology, no matter how good it is, how promising it is, takes time." ∞

Below: Windmills are tested at Rockwell International's Colorado center. Far left, Applied Solar Energy's advanced silicon cell will be cheaper and simpler than the photovoltaic cells in the background. Left, Heliostats at Sandia Lab, in New Mexico, reflect solar rays onto "power tower" to generate electrical energy

A bold new way of life is outlined by this unorthodox economist who combines widely disparate disciplines into one coherent vision of the near future

INTERVIEW

HAZEL HENDERSON

Photographs by Pa. Hal

If someone had put me in Economics 1, I might never have fought my way out," Hazel Henderson once said. And the world might never have gained one of its most original thinkers in that "dismal science" economics, particularly as it relates to science and public policy. Without benefit of formal education beyond high school, Henderson is recognized for her unconventional views and illuminating ideas. Her appointments to several prestigious organizations include the congressional Office of Technology Assessment (OTA), where as a member of the Advisory Council she helps draft studies on a wide variety of future-related issues - solar technologies, for example, or the effects of nuclear war. Much in demand as a lecturer and writer, she roams the globe, attending conferences and spreading her vision of a new economics.

A native of England, Henderson came to the United States some 20 years ago, married, and began to raise a family in New York City. A power plant across the street prompted her first involvement with environmental issues. She became a founding member of Citizens for Clean Air. Later she worked with Ralph Nader and Campaign GM to bring consumer accountability to the largest automaker.

Henderson decided to focus her energies on economic issues and began writing for publications including *Harvard Business Review*, *Saturday Review*, and *The Futurist*. She and her husband Carter Henderson, moved to Princeton, New Jersey, where they established the Princeton Center for Alternative Futures, an informal conference center, operating out of their home, which has been described as a "mom-and-pop think tank."

In addition to her duties with OTA, Henderson has been a director of the Council of Economic Priorities and the Worldwatch Institute and a member of President Carter's Economic Task Force. She is the author of *Creating Alternative Futures* (Berkeley Publishing), a collection of her essays, and *The Politics of Reconceptualization* (to be published in September by Anchor/Doubleday Press).

Omni editor Eric Rosen spoke with Henderson as in most conversations these days, the first topic was energy.

"In the beginning OPEC was vilified as this dreadful cartel. Now some of us realize that it was the best thing that could have happened, and we are praying for them to hold their prices down."

Omni: For more than a decade you've been warning that we are coming to the end of the cheap-energy era. What kind of economy and technology do we need for the era to come?

Henderson: We need to shift to a renewable-resource economy, which implies a shift from our single-minded concentration on physics and engineering to an emphasis on the biosciences and ecosciences. Our goal should be to develop processes with greater thermodynamic efficiency and to align them with long-term ecosystem efficiency. We still have a lot to learn about that.

Omni: What do you mean by thermodynamic and ecosystem efficiency?

Henderson: Our current machines and manufacturing processes grew in an energy-inefficient way because we had cheap petroleum. Our electrical generating systems, for example, produce a lot of what we defined as waste heat. So we've built cooling towers to get rid of it. That's a thermodynamic obscenity: spending extra energy and material to get rid of energy produced in the wrong way. Now we have to develop cogeneration schemes to make use of the low-pressure steam or hot water that we once could afford to waste.

Ecosystem efficiency combines thermodynamic analysis with bioscience. If you're seeking ecosystem efficiency you don't pave over a salt marsh, one of the most productive ecosystems on the planet, for an airport, and meanwhile keep adding oil-based fertilizer to hype the productivity of your farm and.

Omni: What should we look for in new technologies?

Henderson: We should be developing lots of small, rather humble technologies that will give the system a lot more flexibility. That's the trade-off we see in evolution. Success comes from increasing *adaptability* instead of being set in past *adaptations*. The industrial mind-set on which the old economics was built is unsuitable for the new view of bioproductivity, whose basic principles are diversity and redundancy.

Omni: But aren't the renewable-resource sectors following the traditional pattern too? Every analysis of solar cells, for example, counts on mass production to bring prices down, market subsidies to encourage the big companies to get into the field, and so on.

Henderson: There will be some of both. We have to go beyond either/or logic; it's going to be both/and. Much good new science and technology are being subsidized almost unwittingly by the old system.

James Yen, a researcher at Grumman, for example, has developed what's called a tornado wind machine, which extracts energy from a vertical spiral of heated air. Maybe it could be installed instead of cooling towers at power plants. Anyway, while Yen was developing the idea, it didn't fit into Grumman's policies, and the corporate structure worked to reject it.

There are many "human enzymes" in the old system, trying to figure out how to redeploy themselves. There are enough crannies in the system, enough entrepreneurial spirit, enough free information, so that people are beginning to make the changes we need, but the changes are small and local. So they're difficult to identify as a new pattern. They don't show up as the old GNP type of economic growth. I'm sure that much of the renewable resource sector will in fact be derailed, distorted, taken over to serve old institutional needs and be burdened by costly overhead. We'll see both.

Omni: How do these "human enzymes" communicate with each other?

Henderson: By either/or logic. It's a paradox. The old dinosaur institutions have developed an incredible high-technology communication system, computer networks, data banks. And inside the dinosaurs are the "enzymes," networking around obstacles and communicating laterally. It reminds me in some ways of a jungle-drum system, in some ways of the "committees of correspondence" that preceded the American Revolution.

The same technology that makes it possible for a multinational corporation, for example, to sell its patent medicines in many countries makes it possible for consumer groups to get in touch across national boundaries and say, "Beware of this product, they may be about to dump it on you."

Omni: Can everyone be as adaptable as the "human enzymes"? Isn't the stress of change going to be too much for a lot of people?

Henderson: No. I think most people have no particular stake in the old systems; the real difficulty is for the dinosaur institutions that are rigidified around old technologies and strategies of energy and material use that can't be sustained. It's those sectors and the people employed there, who feel the stress.

Omni: Is the Chrysler "bail-out" an example of that?

Henderson: Yes, I think it's quite typical of what we can expect. We shouldn't bail out the institution and all the stockholders, investors and managers who enjoyed the ride up. They got their dividends and stock options; we don't have to underwrite their losses.

We *should* subsidize the redeployment of the workers who are fairly blameless into renewable-resource sectors of the economy. As far as I can see, it's more efficient both socially and economically to support them generously until they're redeployed, or until the Chrysler board has people on it who can turn the company toward production of buses and rapid transit systems.

Omni: Do we need a crisis to knock us over the head?

Henderson: Obviously, we don't need a systemic crisis, in which everything goes to pot all at once. In such a case people simply freak. They can't deal with it. But small,

subsystem crises have social learning experience built into them, especially if we encourage public dialogue, such as we have had over the Chrysler question.

Omni: How has our experience with OPEC been a lesson?

Henderson: I think it was the only shock that could make us realize how far out of line with the rest of the world our energy consumption has been. At the outset OPEC was vilified as a dreadful cartel. Now some of us realize that it was the best thing that could have happened to help us adapt. Now that the cartel has broken on the *up* side and there's petroleum selling at forty dollars a barrel on the spot market, we're going to be praying for OPEC to hold the line. We may even realize how much of the OPEC price increase has been simply an attempt to compensate for the dollar's declining value.

Omni: What are some of the ill effects of our current economic thinking?

Henderson: The two billion six hundred million dollars in claims against Hooker Chemical for what happened at Love Canal, or the millions of dollars that taxpayers are going to have to pay to clean up the Three Mile Island reactor. With conventional economics we've been hiding costs in the environment or in the social system as health or as risks to the health of future generations. Now those hidden costs are coming back to haunt us, and there's no place to hide them anymore.

Omni: Will paying those costs impoverish other sectors of the economy?

Henderson: Yes, inasmuch as they are past-due bills, no longer deferrable. The first thing that companies tend to do in these cases is to go for the "add-on" technology—to build cooling towers when they're no longer allowed to heat up the nearest river. For each such trade-off it's going to take a case-by-case decision between starting from scratch with a new process and adding on to an existing process.

Omni: Should the costs be borne by the public or by the private sector?

Henderson: Inevitably both are going to have to pay. There's tremendous resistance in this country to even quantifying social costs, for example the annual sixty billion dollar cost of alcohol and tobacco abuse. We don't hire people to do it. But in Great Britain, for instance, where the taxpayer foots the whole bill through the National Health Service, many economists are hired to find out who's causing what costs.

Omni: What will those costs do to our national productivity?

Henderson: We should get economists to be much clearer when they throw the word *productivity* around. Traditionally they've defined it as *labor* productivity, per capita productivity. The whole development of industrialism was to increase the individual worker's productivity by increasing the amount of capital investment and energy per worker.

But on the social side of the picture, many other workers were shaken out of the

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system altogether, and *their* productivity fell below zero. They were on the welfare rolls, pushed onto the social-cost side of the system.

If you equate *productivity* with individual workers' productivity and ignore the social costs, then it's no wonder that everyone in Washington is saying, "We must increase our productivity by adding more capital to industrial processes." They've gone inappropriately from microproductivity to macroproductivity across the whole system.

Omni: The demand for increased productivity is often accompanied by insistence on deregulation. Are they connected?

Henderson: The real trade-offs between technologies that create great social and environmental costs, and thus require regulation to control their impact, and more harmonious technologies that don't require regulation in the first place. Nuclear power requires a massive federal bureaucracy for safety policing and waste storage. Local solar and wind power, alternatively, may involve local zoning regulation, but there's no need for Washington to oversee them.

Again, you have to look ahead to foresee the trade-offs. Deregulation of the airlines lowered air fares, but what are the social costs? Small cities lost major-airline service and were left with idle facilities, while airports like Atlanta's became bottlenecks with overloaded traffic controls. There were more accidents on small local carriers. Even if you're flying on a trunk route, you're likely to wind up in an overcrowded flying cattle car. All the new competition has also overextended airlines financially.

Omni: You make a strong case for looking ahead at the consequences of social decisions. But isn't it possible that too much caution can keep you from taking advantage of an opportunity at the right time?

Henderson. Of course. Just as the fusion energy people are saying that we must have more money for fusion right now or else the energy won't be coming onstream in time, the solar energy people are saying that if we don't push photovoltaic-cell development right now, we won't get the benefits of that technology in time. They're all lining up and presenting their data. But the answers aren't in the data. You can't get social directions or moral prescriptions from the data.

You can tell when you're reaching a historical watershed, because you find yourself going beyond the technical questions to right and wrong, good and bad. Why are we doing this? For whom? What are the implications for our children and our grandchildren? For a long time we thought we could push away the philosophical and moral questions, or wrap them up in economic technique and mathematics. We thought cost-benefit analysis could tell us that the greatest good for the greatest number would be served by building a given nuclear-power plant, for instance.

In a period like this one, however, all the technological debates become politicized, and people become aware—my golly!—that the basic level of politics is knowledge itself: how we define problems, what constitutes a problem, what constitutes proof. It's very basic stuff.

Omni. Are we too splintered a society to be able to get down to debate on that level?

Henderson. No, because those are the realities of moral choice that all of us deal with all the time. We know that our activities visit certain costs on other people. If I do something to further my ends, my husband has to forgo something he might like to do.

I think that in the Eighties we're going to see more and more of what I call "the politics of reconceptualization." We're going to have to peel back all the mystifications of technique, all the flurry of data, all of the baroque elaboration of subdisciplines: the toxicologists tracing various illnesses back to various substances, tracing the costs of *x* dollars back to Y Corporation—and get down to some eternal human questions that all of us are very qualified to talk about.

> *"I think most people don't have a stake in the old system. The real difficulty is institutions rigidifying around old technologies and strategies of energy use that can't be sustained."*

Omni: That calls into question all the merits ascribed to expertise and objectivity, doesn't it?

Henderson. Look at the uses of expertise in Washington today: the interest groups fighting "information wars," hiring intellectual mercenaries and building up their computer firepower.

The question of objectivity cuts deeper. We have a three-hundred-year tradition of enormous success in manipulating the world, based on the premise that human beings can abstract themselves from their situation—a species embedded in an ecological system, like all other species—long enough to map and manipulate the world. That will continue to be a successful method whenever you want to manipulate the forces of nature and make something happen. And we still need to do an awful lot of it—to step back and trace the thermodynamic efficiency of the technologies we use, and so on. But we can't let the success of that method hypnotize us into using it as a total philosophy. It won't tell us what kind of future we want.

Omni: The Apollo photographs of the earth gave many people a strong sense of the global system: a realization that we are animals embedded in a finite ecological system. Why hasn't that realization sunk in?

Henderson: Because of the academic lag: all the intellectual investments that have to be written off. People have to recycle themselves, which means getting rid of old models. And many of them are trying to extract the last amount out of their intellectual investments, their old textbooks, and so on before they finally amortize them and move on.

Moreover, we have a vastly overbuilt and overcapitalized educational plant in this country. There are far more colleges than we can ever use, and the potential for using them in real time, education is great. We can take obsolete disciplines that require complete restructuring, such as economics, and begin to replace them with the kind of skills that people need to manage lifestyle changes and personal growth.

We have everything we need sitting there, waiting to be redesigned and rehabilitated. The question is: How fast can we create a debate all through the society where there is already an experiential understanding that something new has to be done? So many people are already far ahead of those committed to the old structures that it's like the dinosaur again. The brain is the last to learn what's happening.

Omni: What should we call the new era?

Henderson: It's the Solar Age. People are already calling it that, but they don't realize its full dimensions. Most think it means flat plate collectors on the roof; they have forgotten that the sun is the only source of energy on this planet. And it's driving everything, including the economy. You can't even have a combustion process without those chemical exchanges occurring in the atmosphere.

Omni: Will we be able to change our cost-benefit analyses accordingly? Can we include those biological ideas you've spoken about?

Henderson: We have to. Until a few years ago my big dream was to incorporate into economic theory all of these important new ideas of bioproductivity and the real physical measures of efficiency from thermodynamics. Take the concept of diminishing returns—an idea developed in early economics. Now that concept fits very well with biological concepts of productivity, where you see S curves dealing with growth, maturity and decline. Up to a certain point you could take a piece of land and add fertilizers to it and increase its productivity, and then at some point if you kept on adding that one additional input, you would reach a level where additional increments wouldn't raise the productivity of the land any further. And in fact additional inputs over an optimum level would begin *decreasing* the productivity.

Omni: Where are we on the S curve?

Henderson: We shouldn't take that highly aggregated view: that the whole system is going to hell and we're going off the curve. Instead, we should look for what is new.

CONTINUED ON PAGE 118

We already know the theory; all that's needed is some advanced engineering

HOW TO BUILD A TIME MACHINE

BY ROBERT L FORWARD

Deep in a subbasement of the White House, President Greatman positioned his right eye against a scanner cup. The wall swung away, and he entered an immense room buried 30 meters below the Ellipse park. Unlike the park overhead, which was littered with splintered remains of the National Christmas Tree, the subterranean room was barren except for a 20-meter sphere nesting in a steel cup that curved into the floor line.

Greatman carefully strode up the rising steel curve to a walkway set at the sphere's equator, tilted at a 45-degree angle to the floor below. Bracing himself up against nearly half again his normal weight, he slowly followed the platform around to the other side, where an operator sat monitoring the controls. She, too, was stuck at an angle to the side of the sphere, but both she and the walkway seemed level to Greatman. It was the room that s oped away. As he walked, he thought about the astonishing machine beneath him. For the last two years it had let him peer into the future and speak to the past.

Greatman handed the operator a message. He had received it a month earlier and evacuated the entire Eastern Seaboard. Now he had to send the warning—to the man he had been four weeks ago.

"I suppose you already know what's on this," he said to the young woman.

"Doesn't everyone?" the operator laughed, her grin blooming like a flower in her earth-brown face.

"Three-kilometer meteor fall. Impact at thirty eight degrees north, seventy two degrees west, 12:54 GMT, 22 December 2023," she read. "Just as it said in the newspapers at the end of November. I figured that you wouldn't dare try to change it, so have the gamma-ray laser all coded."

She made one last check, then a spurt of power shot an infinitesimally short, multihued pulse of high-energy gamma rays down through the supergravity maelstrom of the tiny black hole that whirled at the center of the sphere. The arming point was measured not in angle or distance but in time: four weeks into the past.

"Thanks, Janet," said Greatman. "Keep an eye on it for me, will you?" He walked down the side of the tank and off onto the flat floor toward the command bunker. There was the east coast of the United States to rebuild, but at least the wreckage had no bodies floating in it, thanks to the message he had just sent his past self. He shook his head as the door shut behind him, blocking off the view of the time machine at the center of the room.

A time machine? Impossible. Or so most people think.

PAINTING BY GUY FERY

Yet the most respected and tested theories of physics, Einstein's theories of special and general relativity, allow us to manipulate time. Although we cannot yet control the energies and masses required to make a time machine, we know the principles behind time travel. One of these days, instead of being mindless slaves to the clock, we will be able to send our time craft on a journey through 60 minutes of time as easily as we now send our spacecraft through 60 light-minutes of space.

For many people the very idea grates on the nerves. The logical paradoxes that time travel conjures up are almost mind numbing. The first came with Einstein's special theory of relativity, which said that a clock (or human) traveling near the speed of light would operate (age) more slowly than a clock (or twin) that stayed still.

This effect is real, not just theoretical. Velocity does slow time; it has been measured by taking two identical groups of clocks, leaving one set at home and taking the other set around the world in a jet airliner. The stay-at-home clocks aged more than the moving clocks did.

Yet when the concept was first discussed, many people refused to believe such a thing could happen. All their practical experience indicated that time was an absolute measure, ticking the same way for all things. The confusion was compounded by misunderstanding the principle of relativity. If "everything is relative" and all measurement-coordinate systems are equally good, then why, people asked, can't the traveling twin in the rocket be thought of as fixed while Earth takes the other twin on a relativistic ride?

The resolution of this paradox comes at the turnaround point. Until that point, special relativity says that the aging question is ambiguous. In order to compare the relative times of two objects, they must both be at the same place. When the traveling twin activates the ship's rockets to return to Earth, the coordinate system that had been traveling with the ship continues on its way. After he abandons the coordinate system he started with, the traveling twin can no longer claim "everything is relative." The stay-at-home twin is still with his original coordinate system and thus has not moved; his price for this stodginess is aging at a precipitous rate compared with the traveling twin.

So one way to make a time machine is to find a way to move at velocities close to that of light. Unfortunately, the special-relativity time machine works only one way. You can go into the future more slowly than normal, but you cannot go back in time.

Still, this kind of time machine has its uses. If you were sick and no cure existed for your ailment, a sojourn in a relativistic rocket ship could keep you from dying until a cure could be discovered. If you had a rich but very healthy aunt, then a few days spent at 99.99998 percent the speed of light could let you enjoy your inheritance while you're still youthful.

There are more immediate applications, however.

If you had some hard-to-make element so evanescent that it would decay before you could even measure its characteristics, moving the element from the generator to the measuring machines at near-light speeds would let you do the job. This type of "time machine" is used today in all laboratories that study the elementary particles generated in huge atom smashers.

The processes that generate these particles are so energetic that the particles emerge at nearly the speed of light. Many of the newly generated particles live less than a billionth of a second. If their "clocks" did not slow down, the particles could not travel more than a few centimeters before decaying. Because of their high speed, however, they age slowly and survive the tens of meters from the generator to the detectors, where they are analyzed.

On account of the detailed scientific analyses of the "twin paradox" problem

"We are only beginning to understand Einstein's theory of gravity, but we already have designs for several time machines. Given the mandate, the money, and the mass, they will be built."

and the experiments that prove the effect is real, the twin paradox is no longer a paradox. Except for a few who still cherish the idea of an invariable, unchangeable time, the human race had absorbed this unusual behavior of nature at high velocities. Not only do we live with this "one-way" time machine, but we also use it.

But how do you build a "real" time machine—one that goes both backward and forward in time? What Einstein's laws tell us is that if we collect enough mass in one place, its gravity field will distort the time and space we know. In this region, where time is confused, it becomes possible to move ahead or backward through the hours as if they were kilometers. The process becomes easier if the mass is moving or if it carries an electrical charge.

We are only just beginning to understand all the ramifications of the general theory of relativity, Einstein's theory of gravity, but we already have tentative engineering designs for a number of time machines. Theorists may complain that such devices would be unstable, and environmentalists may be appalled at the resources that will be needed, but the gravitational engineers of the future will build the time machine if they are given the mandate, the money, and the mass.

Einstein's theory allows many shapes for a time machine. It seems that any object that produces an ultragravity field can create time-confusing regions. There are some shapes, however, that can produce regions that might be usable by humans. Just how certain it is that a given time-machine design will work depends on how closely its designer has been able to follow Einstein's equations.

One configuration that can act as a time machine is a dense, rapidly rotating object that is collapsing to form a black hole as its spin speed increases to the speed of light. This extreme version of a spinning collapsing star can be described by a rigorous, mathematically exact solution to the full, non-linear Einstein gravity equations. The solution is called the Kerr metric, after the reticent theorist Roy Kerr who probably was dismayed when he found that the mathematical beauty he had discovered might someday have a practical application.

The Kerr solution describes the gravitational field on the outside of a collapsing, rotating mass that is approaching high density. Large stars are rotating masses, and as they reach the end of their short lives, they collapse into rotating black holes. One would expect that a real collapsing, rotating star will form an elliptically shaped black hole, bulging at the equator because of its spin. It is possible (and probable, given the human race's proclivity for fooling with nature), however, that this pancake-shaped collapse could be induced to form a doughnut, with all the dense mass out in the rotating ring.

Once such an object is formed, then Einstein's equation indicates that the empty region in the center can be a gateway into time. If you go through the hole in the doughnut, you don't come out the other side. Instead you enter a strange type of hyperspace. Your forward space dimension has turned into a time dimension, and the time dimension has turned into a space dimension. If you move in the hyperspace against the rotation of the ring for a number of rotations, you will observe nothing unusual happening. When you return through the hole to normal space-time, however, you will find that you have returned to your original position in space, but your position in time has moved backward a number of years.

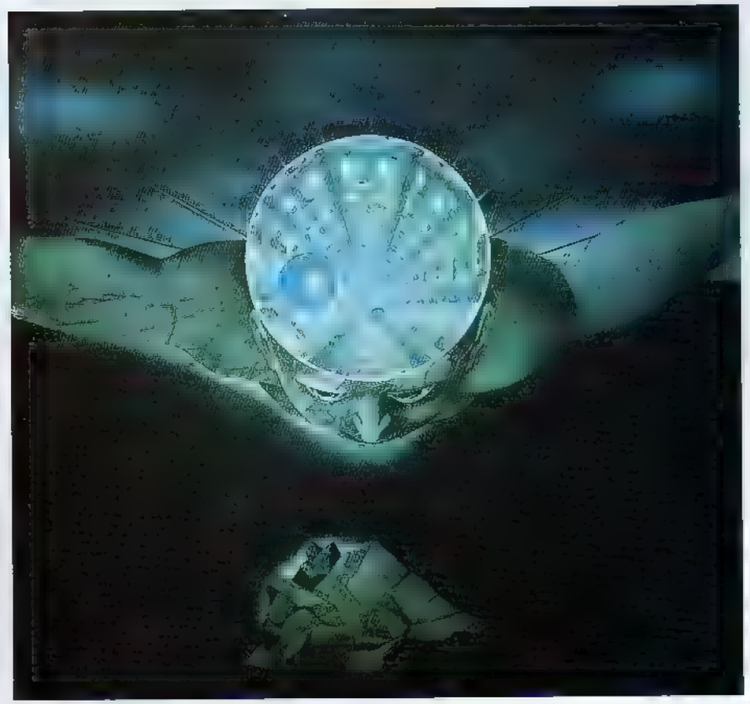
Even though Kerr precisely followed Einstein's gravity equations in designing his time machine, there are mathematical theorists who say that the special conditions required by his time machine cannot happen.

Papers have been written to show that even infinitesimal deviations from the special symmetries of Kerr's solution (such as would be caused by an object trying to use the time machine) would drastically alter the structure of the Kerr solution. They con-

CONTINUED ON PAGE 122

Warping the limits of time plumbs the deepest sources of wish fulfillment

TIME TRAVELERS



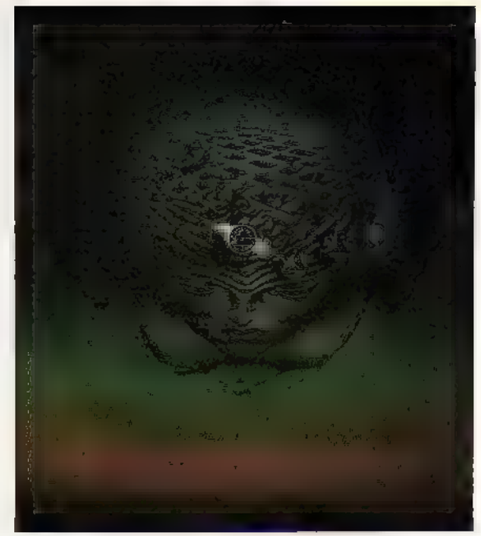
All of us share the impulse to escape the tedium of everyday life. The desire to travel through time reflects our unwillingness to live with things as they are. Time travel enables us to experience the romance of the past and the mystery of the future, to try to change our world.

H. G. Wells invented the modern time travel theme. In *The Time Machine* Wells's hero undertakes his journey out of scientific curiosity. "I saw the moon spinning swiftly through her quarters from new to full, and had a faint glimpse of the circling stars . . . Gaining velocity, the palpitation of night and day merged into one continuous greyness . . . the jerking sun became a streak of fire, a brilliant arch, in space . . ."

In Harlan Ellison's "The Prowler in the City" the time traveler has no choice: "suddenly . . . he was flooded with light. And when he looked up he was in that other place. Paused now, only a few minutes after the transfer, he leaned against the wall of the city and recalled the flight."

Paintings by Richard Lon Cohen and Jon Townley (left), and Hans Ulrich Osterwalder

BY ELLEN DATLOW



Time traveling presents unique risks. What if you went back in time and killed your own grandfather? Or what if you found yourself in the position of Philip K. Dick's hero in "A Little Something for Us Tempunauts"? "... then it hit him. We're in a closed time loop ... we keep going through this again and again ... each time imagining it's the first time...."

There are also blessings. An old doctor in C. M. Kornbluth's "The Little Black Bag" finds a unique medical kit from the future. "The blade sank in, miraculously cutting only the dead tissues ... declining to affect any system or organ except the one it was tuned to, could you say?"

Paintings by Pamela Mower (left), Hans-Ulrich Osterwalder

There are diverse views of the effects of traveling in time. One is presented by Henry Kuttner and C. L. Moore in "Vintage Season". "The physio-temporal course tends to slide back to its norm . . . That is why it is so hard to force any alteration."

In his story "A Distant Thunder" Ray Bradbury warns that "a little error here would multiply in sixty million years, all out of proportion," changing the future.

And Michael Moorcock writes in *The Hollow Lands*: ". . . once a time traveler has visited the future he cannot return to the past. If he did he could alter the course of the future. . . ."

Today time travel is a dream, tomorrow we may wake to find it a reality. ∞

Paintings by (clockwise from above) John Harris, Peter Knifton, and Michael Whalin

FICTION

In a society ruled by zealots, minor indiscretions can be crimes against the state

BY FRANÇOIS CAMOIN

SOME OF MY BEST FRIENDS ARE AMERICANS

I didn't look before I crossed the street, but it didn't matter; Manhattan is pretty nearly empty of cars nowadays, except when an Important Person comes along in his Volkswagen or his Mercedes, pushing the walkers and bicycle riders out of the way, the driver leaning on the horn and shouting curses at us. Nobody yells back; we've gotten used to being cursed, these last few years, and to moving slowly. There's no sense in moving fast if you're not going anywhere.

I wish I could afford a bicycle, but I'm a shipping clerk, and on eighty thousand dollars a week I'm glad to pay the rent and eat. Pan-Islam Trading doesn't pay native workers much, but a one-handed man is lucky to find work anywhere. So I don't complain. Though in one way I'm less of a risk than other men, I have a lot more to lose if I get caught again. Besides, the job is useful in other ways.

On mornings like this, in late April, walking isn't so bad; the sky is ten times as blue as it ever was in the old days when anybody who had a hundred thousand dollars could buy a car; the air smells better, and down some of the wide streets you can see for miles. I'd trade it all for a washing machine or just lights past midnight, but that time is gone forever, because we were stupid. Except in Forest Hills and the hotels on the East Side, where the Arabs have those things—Arabs and a few Americans.

PAINTING
BY ETIENNE SANDORFI

One of these days I'm going to pay them back for my hand; right now I mostly try to survive. Now and then I think about Mexico, where I hear that even laborers drive big cars and live in houses with a dozen rooms and with all kinds of electric appliances. But the border is closed tight, the Republic doesn't care, but the Mexicans are scared of us. We're too hungry. There are guard towers every hundred meters along the Rio Grande, and the big, well-fed soldiers like to shoot Americans who try to go across.

I hurried along so I could get past Times Square before the execution. It was announced on the morning broadcast by a mullah who looked like an American; religion was a way out. Half our television evangelists saw the light right away and started memorizing the Quran. The man who was going to die was a Jew; he'd hidden out during the Oklahoma Transport and had used a false ID card to live in the Holy City of Brooklyn, thus cheating the Law.

I didn't much like the mullah with the blue eyes—there are some things a man doesn't do—but I didn't feel one way or another about the Jew. Jews are Jews and the world is the world. You have to go along to get along—that's always been the American Way. I have graduated from sentimental foolishness, and that stump on the end of my left arm is my diploma.

A woman brushed against me. Her chador slipped, I caught a look at her face, and a tremendous sexual urge caught me off guard. They say we can't control ourselves, and maybe they're right. It wasn't until I'd walked half a block away that I remembered that she'd been fat, homely and middle-aged. I had a pretty young wife once, but she died in the riots of 89 after President Grey had been assassinated. We'd been married a year.

I passed an American selling skin-darkening lotions and black hair dye out of a pushcart, and I nodded to him. He used to be a high-school civics teacher; now he's an old man who makes a living helping the unlucky ones. I don't use his stuff, but I don't blame the people who do—pale skin and blond hair make it harder to find a job these days, or a place to live. Even if the landlord is an American.

It was later than I thought, when I got to Times Square, they were leading the Jew up the steps. He wore dark pants and a white shirt, like an old-time salesman; he was an old man, and he looked frightened and weak. The mullahs took his arms and pushed him down on his knees, the executioner stood behind him, motionless. The old man seemed not to know exactly what was happening, and I hoped they'd given him something. But at the last second he raised his head and spoke loudly and clearly in Hebrew. Behind me someone whispered, 'Hear, O Israel, the Lord our God, the Lord is One.'

I looked around, but the faces were ordinary American faces. I turned back just in time to see the sword carve out a piece of that very blue sky and start down. I closed my eyes, but I couldn't shut out the meat-cleaver sound of the blow; it echoed from the tall buildings, repeating itself for a long time.

Mounted cops began to clear us out, kicking at anybody who didn't move quickly enough. Most of them were big, beefy cheerful Irishmen. Our new masters left us our native police, it allows us to work off our hate and frustration on one another. It works—I hate them worse than I do the Arabs.

I ducked into a doorway to let one go by; the bastard was enjoying his work. His club caught a middle-aged man on the side of the head and sent him staggering in a crooked line toward me. I helped him sit down. He was better dressed than most of us, a ragged business suit mended at the knees and too wide for him in the waist.

"I'm obliged to you, friend," he said.

"You're going to have a nasty bump," I said. "How do you feel?"

"I wish I could afford a bicycle, but . . . on $80,000 a week I'm lucky to pay the rent and eat. Pan-Islam Trading doesn't pay . . . much, but a one-handed man is glad to find work."

The man was white and sweating, but he grinned. "I've been hit harder." He reached up to feel the place and winced. "I'm Harry Landon," he said.

"Michael Stein," I said.

He raised an eyebrow, which made him wince again.

"I'm not a Jew," I said. "My great-grandfather came here from Germany in 1919 to get away from the depression. He was a Lutheran."

"I didn't mean anything," Landon said. "But it's an unusual name these days. I'm surprised you haven't changed it."

"A man doesn't change his name because some people don't like the sound of it."

"No offense," Landon said. He looked across the square. "A terrible thing," he said. On the platform the mullahs watched while a red-handed man scrubbed away the blood. The body had already been removed. I shrugged.

"Don't you care?" Landon asked.

"They own the world," I said. "Anyway, until the oil runs out. Then it'll be somebody else's turn. That's history."

"People make history," Landon said.

"Sometimes," I said. "Anyhow, look at the bright side. You can walk anywhere in New York any time of night now. There aren't any muggers or drunks or pushers."

"No thieves." Landon's eyes traveled to the end of my arm; he shut his mouth and looked embarrassed.

"That's okay," I said. "I'm not self-conscious about it."

There are a lot of us. In the old days we would have organized ourselves and lobbied in Washington for special privileges. Many Americans, at first, didn't believe how efficient the Law could be; we were used to lawyers and appeals and suspended sentences. That was why they didn't have enough executioners to go around, and General Electric had come up with the Booth. They use only human executioners for capital cases now.

"Doesn't it make you mad?" Landon said.

"The thing is to survive," I told him.

"Yeah," he said.

"Are you all right now?"

"Sure," he said. "Thanks."

"Anytime."

I was sure I'd never see him again. The cops were gone and the square was filling up with people walking to work. Men shuffled along, in no hurry to get anywhere. Most of them wore the same sullen, half-asleep half-dangerous expression. It took me a minute to remember where I'd seen it before—in an old *National Geographic* photo of Navajo Indians. The janitor in my building has crates of old magazines, and I go down to the basement often to leaf through them and remember how the world used to look.

Bob, the janitor, used to be a chemist for the state Food and Drug Commission, which is now a committee of holy men. He is the cleverest man with his hands I've ever known, and he has a little still which is disguised as part of the building's hot-water system. He makes a powerful moonshine out of whatever we can scrounge up for him—potatoes, corn, raisins. Peelings when we can't get anything else, which is most of the time.

I got to work fifteen minutes late, and nobody gave a damn. It amuses the Arabs to see us live up to our reputation for general shiftlessness. 'Tomorrow-tomorrow,' they like to say to us with a fake American accent, and then they laugh like hell. "You have to stay on top of Americans every minute,' they tell one another when they think we can't hear, "or they'll fall asleep on you. They're lazy but they're clever. That's how they got where they were."

I have my corner at the back of the warehouse, with an old metal desk, stencil brushes, and a computer terminal that works about two thirds of the time at best. When it's on the blink, I type out the waybills with one finger on a Stone Age IBM and file the packing slips in the drawer of the desk. They leave us pretty much to ourselves, little Johnson and me; he runs the forklift and I try to make sure that he stacks the right boxes on the right dock most of the

time. Now and then Ahmed comes down to make sure our end of the building is still there. He's not a bad sort for an Arab.

Sometimes he also comes down to open a crate personally (usually one from the Far East by way of California) and I have to pretend I don't see the little plastic packages he slips into his pockets.

And sometimes I send and receive little packages of my own, more powerful than Ahmed's. Or maybe they're not. His heroin probably does more harm to the Republic than the loss of an occasional Mercedes with an important Person in it, or explosions in the men's rooms of various government buildings. I wouldn't even call us a movement — at best we're just keeping the spirit alive in case one ever comes along. Clerks and janitors and ditchdiggers and street sweepers; maybe there aren't more than a hundred of us in the whole country. I don't want to know. I just send my packages and hope for the best.

When I got home that night I turned on the TV. Everybody gets one, courtesy of the Republic. I think it's for our education. They're second rate GE sets — the picture flickers, the colors are false, and the sound is always fuzzy — but it's something to do until the power goes off at midnight. Sometimes we get the ayatollah speaking his peculiar brand of English, sometimes realistic dramas about the glories of socialism.

Tonight they showed a film of the execution, they had looped out the sound so that although the old man's lips moved in the close-up nobody could tell what he was saying. When the sword went up I reached over and shut off the set and climbed down the stairs to see Bob.

He handed me a glass. "This is about the last of the old batch," he said.

It had a slight yellow tinge and tasted bittersweet, like fuel oil, but it made the world a good deal more tolerable.

"The next one should be better," he said. "I got ten pounds of real cane sugar to put in it."

I picked up an old *Newsweek* and leafed through it carefully. It was a January 1988 issue, and the lead story was President Grey promising to close down the last five nuclear power plants. They had a picture of him sitting cross-legged on his desk in the Oval Office, smiling at the secretary of the Interior. She was smoking a cigar.

"Those were the days," Bob said.

"I wonder why she shot him," I said.

"Well, if it hadn't been that, it would have been something else," Bob said. "People simply figured it would go on forever, that the scientists would keep on inventing things to let us live the way we were used to. Even after San Onofre melted down, the only people who really howled were the ones who'd had relatives in Oceanside or Laguna Beach."

"California," I said.

Bob looked at me. "It was never *that* good," he said. "Not even before."

"Sure it was," I said.

He shook his head. "People weren't really happy."

"You don't understand," I said. "Or you don't remember. They could buy anything they wanted at the supermarket, they all had two or three cars, the women walked naked on the beaches. How could they be unhappy?"

"I was there," Bob said.

But he's getting old, and I don't think he remembers it right. The Mexicans we see on television now and then, when the ayatollah makes a state visit, look happy to me.

Two days later I saw Harry Landon again. I was in line to buy lunch from the pushcart man on Fifty-first Street when I turned around with my bread and beans balanced on an old piece of newspaper, I saw him standing three men back of me.

"How're you doing, friend?" he said. He was wearing the same ragged suit, and there was a bruise big as a hand on the side of his head, above the ear.

He looked across the square. "A terrible thing," he said. On the platform the mullahs watched while a red-haired man scrubbed away the blood. The body had been removed.

He worked for a jewelry company across the street from the lunch cart. "Deliveries," he said. "I've got a three speed bicycle and a leather pouch I sling over my shoulder. Hell of a way to make a living, but it's steady."

"What did you do before?" I asked.

"I was in real estate. Made a fortune and then woke up one day and found I couldn't buy a dozen eggs with all the money I had in the bank."

I remembered my father pushing a wheelbarrow full of hundred dollar bills to the Safeway," I said.

We got into the habit of eating lunch together. We generally sat on the same bench and watched the people and talked about the old days. Harry had lived in the San Fernando Valley; his wife had been killed in the Santa Barbara firestorm. His two kids had made it to Mexico before they'd canceled the American quota.

"They send me a little money sometimes," he said.

It was a quiet summer. I got to know Harry pretty well. One of the front-office types came by and caught little Johnson sleeping on a pile of boxes; he was going to fire him, but Ahmed talked him out of it.

The first week in September Jerusalem fell to the PLO Second Armored Division and the ayatollah announced a week of national rejoicing. When I saw Harry at lunch the next day, he looked as if he'd been drinking all night.

"It's finished," he told me.

"You have to admire them for holding out as long as they did with nothing but what the French could give them in the way of weapons," I said. "The ayatollahs made a deal to let the survivors settle in Oklahoma."

"Settle? Do you know what they do with Jews in Oklahoma?" Harry said.

"Sure. I've seen it on TV. It's all big irrigated farms now. They say the Jews are making a paradise out of it."

"Have you ever talked to a Jew who's been there?"

"How could I?"

"I have," Harry said.

Two cops came by slowly on their horses; they looked fat and sleepy but under the caps their eyes were sharp. "I'm a Jew," Harry said.

"Are you crazy?" I said.

"Today? A little, maybe."

"But you talk like a cowboy," I said. "You look like an American."

"Yeah," Harry said. "My folks were from Dallas."

"Why tell me?"

"I don't know," Harry said. "Would you like me to tell you what it's really like in Oklahoma?"

"No," I said. "I don't want to know anything about it." I got up and walked away from him as fast as I could, back to my work. "Good-bye, Harry," I said. "Good luck."

I brought my lunch to work the next day and ate it at my desk. In my corner with my stencils and my crates and my Japanese computer terminal, I felt safe. It's not as if I'd voted to send the Jews to Oklahoma or to give VERTOL fighters to the PLO. Nobody asked my opinion. It isn't that kind of Republic.

I didn't want to be near Harry. He was bound to be caught and transported or worse, and anybody involved with him would be in trouble with the Law, too. A man who's already lost one hand can't be taking chances. The one thing I was certain wasn't ever going to happen to me again was stepping up to the Booth.

It wasn't the pain — they're not interested in pain, only in teaching a lesson. But every time I thought about it I wanted to lie down on the floor and curl up in a ball with my left arm hugged tight against my belly. Sometimes I wake up at night and can feel every one of the missing fingers: I have to pump my flashlight and point it at the end of my left arm before I can convince myself they're gone.

The only chance I'm taking is with the little packages Bob makes for me and ships out in Pan Am's crates. But it isn't as risky as it sounds. As enforcers of the Law, the

Arabs are terrific as detectives, they're useless. I could do this for a hundred years and they'd never catch on.

Little Johnson went around happy all week. "What did we ever get from helping them in the old days?" he said. "Nothing but a lot of static and interfering with our politics. I'm glad they're gone."

"Hurry up with your lunch," I said. "We've got work to do."

'Ahmed said they might give us a raise." He snapped his lunch bucket closed and went off to find the forklift.

'Stop that damn whistling," said. "You're driving me crazy."

The next week I couldn't stand it anymore and I went back to find Harry. Talking to him made the world a little more tolerable, like Bob's moonshine, anyhow; he might not have been caught. He surely didn't look like the Jews in the TV plays with their dark clothes and their funny way of slouching along.

He was on our same old bench, eating his beans and bread. The leather pouch with God knows how many diamonds and rings and bracelets and other precious things in it was lying beside him, as secure as if it were in a vault. Nobody steals anymore. It isn't safe.

"How come they didn't get you in the first place?" asked. "I thought they went through the computer files and found all the Jews."

"Do you want to know?" Harry said. He made a place for me on the bench.

"No. You're right. Forget it. Let's talk about the weather."

In late October the city is sometimes so beautiful that we can forget for a while that it isn't ours anymore and we're just tolerated here because we're cheap labor. White, puffy clouds hung in the sky like personal blessings from Allah, the air this noon tasted like cut grass and the sea; the Crescent and Bars rippled and snapped in the breeze over the doorways of the buildings all up and down the street. Even the cops looked a little bit happy.

'In California the weather was sometimes like this for months on end. We could pick oranges right off the trees.'

"It must have been something," I said.

'It still is. You ought to see it."

"Sure. I'll just buy a ticket on the next plane."

'It isn't as easy as it was before, but it can still be done." He would do it for me more than that, though I pestered him for a while. Next to paying back some Arab for my hand, the thing I'd like most in the world would be to see California once. "All in good time," Harry said. "Maybe someday you'll get a chance."

"Tell me," I said. "Of all the things you remember from before, what do you miss most?"

"The food," Harry said. "I never have enough to eat now. And even what we get is miserable, inedible. I'm sick to death of chili and beans."

"The Mexicans used to love them," I said.

"Maybe the Americans will too, in another hundred years. Right now I'd give anything for a steak. I get depressed sometimes just because I know I'll probably never eat one again. What about you?"

"I don't know. I was still in college when things started to go bad, and I mostly ate peanut butter and yogurt anyway."

'Look over there," Harry said. "On the corner of that bench. We sit here dreaming about food and they've got so much they can leave lying around for the pigeons."

"It's an apple," I said. 'Do you know how long it's been since I tasted an apple?" It was a little scrawny, yellowish-green fruit, lumpy and misshapen, but it made my mouth water. So I had to keep swallowing.

"I'm going to eat it," I said.

"Better not," Harry said.

'Come on," I said. "A lousy apple. Those bastards can buy a bushel of them anytime they feel like it. Who's going to care?"

I could already taste it. I took a small bite

"He was bound to be caught and transported or worse, and anybody involved with him would be in trouble with the Law, too. A man who's already lost one hand can't take chances."

and turned to grin at Harry. He was gone. Something touched my shoulder.

"You!" the cop said. His stick tapped me on the ribs. "You! Is that your apple?"

The little kid beside him couldn't have been more than twelve; under the headdress his brown face had the expression of one who owned the world and knew it.

"It's mine," he said. "This man is stealing it."

'No," I said. 'Wait a minute. You don't understand. No."

The kid pointed to my left arm. "He is already a thief," he said.

The jails aren't crowded. Nobody stays in them very long. The Law was invented by a nomadic people, it doesn't believe in locking up a man for punishment. The cell was reasonably comfortable and very clean. The guards were Arabs, they weren't brutal and they weren't friendly. They treated me as if I were already a corpse.

The dinner was better than anything I'd been able to afford in several years; there were actual chunks of lamb in the stew. I was just finishing when the door slid open and a guard stood aside to let Bob come in.

'Harry called me," he said. "How're they treating you?"

'Pretty well," I said.

"I brought you something."

It was a *National Geographic* with a cover photograph of Santa Barbara before the LNG tanker blew up in the channel, when there was still a Santa Barbara. The sea in the picture was an extraordinary blue and the green palms in the foreground seemed to explode from the tops of their trunks, a wonderful dusty green. I looked down and saw myself fingering the pages.

"Take it back," I said. "Here." I wadded up the magazine and threw it across the cell onto his lap. "Go home," I said. 'You can't do me any good. Get out of here."

They turned off the lamp in my cell so I could sleep, but there was light from the hallway; in the half glow I found myself studying my right hand. What a clever piece of creation it was: the complex articulation of the knuckles, the fleshy pads at the end of the fingers that give us a grip on the world, the wrist which is more ingeniously joined than any machine. And in a few hours that masterwork of bone, muscle, tendon, garments, skin and blood vessels was going to be lying at the bottom of a stainless steel can, clenched on nothing, rigid and dead. The fingernails. The fingernails alone were little works of art, ridged, delicately shaped, subtly colored, no two really alike if you look close.

The Booth was in another part of the building, I knew, in a chamber that opened off the courtroom so that the sentence could be carried out immediately. I knew very well what it looked like. It was about the size of a photo machine and had the same little curtain for privacy. Instead of sitting down and staring into a mirror, you stood in front of a flat metal wall with one round hole in it, a little less than shoulder high. The mullah who stepped in with you helped you put your arm into it, up to the elbow. You wore a special white shirt with no sleeves. A clamp took you softly and firmly just above the wrist, a cuff sensed your blood pressure, a computer counted your pulse. It was all automatic. The needle found your arm and numbed it, and there wasn't any real pain. Only the sudden terrible sense of violation and loss.

I curled up on the floor and hid my right hand in my belly so they couldn't find it. I tried to go to sleep and dream about California. I wondered whether they'd set me free if I denounced Harry as an illegal Jew. Probably not, and anyway there are things you simply don't do. I don't give a damn about the Jews, but Harry was a friend.

It wasn't going to hurt. I told myself. I hugged my hand. I thought about the palm trees and that wonderful warm blue ocean. There would only be the prick of the needle and then the numb feeling that crept slowly up the arm. No real pain. I thought about the beaches. The naked women walking. The sea. ∞

MEN LIKE US

CONTINUED FROM PAGE 65

Blast, and who would remember that?'

He looked around the room. The eyes that met his dropped swiftly. 'There's been some born here in Moseby haven't there?' Smith asked, his words thrusting like knife blades and no doubt in them. 'Where are they now?'

The man they had called Scottie bit through the reed stem of his pipe. He spluttered, and the front legs of his stool clacked on the puncheon floor.

'Say now, 'm not here to pry,' Smith continued swiftly. 'What you do's your own business. For my own part I'd appreciate another mug of this excellent beer.'

Chairs scraped in agreement as all the men stood, stretched, and moved to the bar. Modell drew beer smoothly, chalking drinks on the board on the back wall – everyone but Smith was a local. The innkeeper even broached a new cask without noticeable delay. Several of the company went out by the rear door and returned adjusting their trousers. There was a brief pause as everyone settled back around the fire. Then Scottie swallowed, scowled, and said belligerently, 'Alright, what about the Changelings?'

'Pardon?' The traveller's eyes were friendly above the rim of his mug, but there was no comprehension in them.

'Oh, come on!' the local said, flushing in embarrassment. 'You know about the Changelings. Everybody does. The Blast made them. They were men before, but now they grow blue and change their shapes and walk around like skeletons, all bones.' Scottie lowered his eyes and slurped his beer in the silence. At last he repeated, 'Everybody knows.'

Gently, as if the suggestion did not appear as absurd to him as it suddenly did to everyone else in the room, Smith said, 'I've seen some of the Strike Zones, I guess I've said that. There's nothing there, friend. The destruction is total, everything. It isn't likely that anything was created by the Blast.'

'The Blast changed things. We can all agree there,' said Carter unexpectedly. Eyes turned toward the policeman seated at one corner of the hearth. 'Random change.' Carter continued to muse aloud. 'That'll generally mean destruction, yes. But there was a lot of power in the bombs, and a lot of bombs. So much power that... Who knows what they could have done?'

Smith looked at the policeman. He nodded again. 'Power, yes. But the *chance* that the changes – cell by cell, atom by atom, would be... not destructive. That's a billion to one against, Mr. Carter.'

'We – the books say there were billions of men in the world before the Blast,' the policeman said, spreading the fingers of his left hand, palm upward.

The traveller's scarred left hand mirrored the policeman's. 'It's a wide world,' he said, 'as you must know and I surely do.' He drank, smiled again, and said, 'You're familiar with bombs, it would seem, friend. I've heard talk in my travels that there was a stockpile of bombs in the mountains around here. Do you know that story?'

Carter looked at Smith with an expression that was terrible in its stillness. 'Modell,' he said in the silence, 'it's time to throw another log on the fire.' He paused. The innkeeper scurried to do as directed. 'And it's time,' the policeman continued, 'to talk of other things than the Blast. What sort of game do you find in the Hot Lands, for instance?'

'Well, I snare more than I knock on the head with my sling,' Smith began easily, and the room relaxed a little.

They talked and drank late into the night. Smith told of gnarly woods and of following miles of trails worn no higher than a hog's shoulder. The locals replied with tales of their farms in the river bottoms, managed for them by hirelings, and the wealth they drew from shares in the smelters' profits. Few of them actually did any of the heavy, dangerous work of steel production themselves. Moseby was a feudal state, but its basis was the power plant, not land.

When Carter finally left, only Scottie and another local remained in company with Smith and Modell, and the talk grew looser. Finally Scottie wheezed, 'They drift in here to Moseby, up the river and down. You're

"Fire! We can have light at night! We can heat the cave! We can cook our meat! We can light up a joint!"

the first across the mountains boy. I'll te the world. We put 'em to work in the fields or the smelter, or they crew the barges for us But they're not Moseby they're not of the Assembly. It's us who've got the power, under the chief and the police, that's We keep the light, and then "

Model touched the line of Scottie's jaw, silencing him Scottie's surprise bloomed into awakened fright "You've had enough tonight, old man " the innkeeper said Pook, you too Time for you both to get home and for me to get to bed

And me " Smith agreed Model had already brought out blankets and opened a side bench into a cot "Though first I'll take a leak and, say a walk to settle my head If you leave the door on the latch?"

Model nodded dourly 'You've been listening to that fool Howes and his talk of the girls across the Assembly. Him with a wife and six children too! Well, don't try to bring one back here with you They should know better but if one didn't, it'd be the worse for both of you." The innkeeper blew out one of the lamps and moved toward the other

Smith urinated in the open ditch behind the building letting his eyes readjust to the moonglow Then he began to walk along the sewer with a deceptive purposelessness. In the shadow of the house nearest the creek he paused, eyeing the nodding guards across the gorge The traveler took off his boots He ducked into the ditch and used its cover to crawl down onto the creek bank

The rock was steep, but it was limestone and weathered into irregularity enough for Smith's practiced fingers to grip Smoothly, but without haste, the traveler slipped along below the line of sight of the guards at the power plant. When he reached the bridge trestles he paused again breathing carefully. His hands examined the nearest of the handsawn oak timbers tracing it from where it butted into the rock to where it crossed another beam halfway to the stringers Smith swung onto the trestle and began to negotiate the gorge like an ant in a clump of heavy grass

Any sounds the traveler might have made were muffled by the creek Smith edged left toward the west corner of the building. The wall there was built almost to the rim of the gorge Smith's clothing matched the color of the wet stone so that his outline was at least blurred for a potential watcher from the village, but lack of alertness on the guards' part was his real defense

Smith raised his head. Both guards were nodding in their chairs crossbows leaning against the doorposts beside them The traveler swung up lithely A step later he was hugging the power plant's west wall The stone hummed

The building was as massive a construction as anything Smith had seen created after the Blast The walls were dry stone using the natural layering of limestone and their one-meter thickness to attain an ade-

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quate seal without mortar. Their weathered seams made it easy for someone of Smith's strength and condition to mount the five meters of blank wall to the lighted slits just below the roof. The interior was much as the traveler had expected it to be: much as he had seen it before here and there across the face of the world.

Six huge electric motors were ranked below him. They were being used as generators, driven by a complex pattern of shafts and broad leather belts. Only one of them was turning at the moment. When the smelters were working at full capacity and called in turn for the maximum output of the plant, the room would be a bedlam of machines and their attendants. Now one man and a woman were sufficient. The light of the naphtha lanterns illuminating the chamber may have exaggerated the attendants' pallor, but they certainly saw less of the sun than the villagers across the stream did. It was hard to believe that control of this apparatus was left to slaves, yet it was even more unlikely that freemen who knew what they were doing would enter the chamber below.

In the center of the north wall, built against the living rock of the mountainside, was the reactor.

Its genesis was evident, for the black hulls of ten fusion bombs were ranged along the partition wall to the east. Smith, his head framed in the narrow window, licked his lips when he saw the bombs. They would no longer be weapons: the plutonium of their fission cores would have decayed beyond the capacity to form critical mass when compacted. But those cores, taken from their cocoons of lithium hydride and the inner baths of deuterium, could still fuel a reactor.

The latter was an ugly mass of stone blocks overshadowed by a mantislike derrick. Steam from the reactor drove the pistons of a crude engine. Unlike the pre-Blast electric motors, the steam engine had been manufactured for its present purpose. Inefficient, it leaked vapor through seams and rope gaskets, but the power to create steam from water was virtually inexhaustible on the scale required here.

Manufacturing skill and not theoretical knowledge had frequently been the brake on human progress. Leonardo da Vinci could design a workable aircraft, but no one for four hundred years could build an engine to drive it. Nuclear power technology was so simple, given the refined fuel and expendable humans to work it, that an age that could not manufacture smokeless powder could nonetheless build a fission plant. All it would have taken was a weapons stockpile and a technician or two from Oak Ridge vacationing in the mountains at the time of the Blast.

It was what Smith had come to learn.

There was a new sound in the night. A score or more of men were thudding across the bridge to the power plant. Smith ducked his head beneath the sill of the window. As he did so, the siren on the roof hooted ferally. Knowing that there was no escape downward if he had been seen, the traveler slipped sideways and began to clamber up between a pair of the windows. As his fingers touched the edge of the slates, a voice from below shouted, "There he is!"

Smith gathered himself to swing onto the gently sloped roof, something tapped his knuckles. He looked up. The muzzle of Carter's M16 stared back at him. The policeman smiled over the sights. "I saw something block one of the plant windows," the local man said. "Thought it might be worth waking the guards for. Now, *friend*, you just climb down easy to where the people are waiting for me and the boys here won't wait for the ceremony."

The pair of guards flanking Carter had faces as tense as their cocked crossbows. Smith shook his head ruefully and descended into the waiting manacles.

The siren gave three long cries as the guards marched Smith back across the bridge. Citizens, warned by the initial signal, began walking out of their houses, the men armed, the women bleak as gray steel. They drifted toward the shrouded platform across the long axis of the Assembly from the bridge. None of the citizens seemed to want to be the first to reach the common destination. They dawdled in pairs and trios, turning aside as Smith and his captors passed among them.

"There was a new . . . sound in the night. A score or more of men were thudding across the bridge to the power plant. Smith ducked. . . . As he did so the siren . . . hooted ferally."

The chief and the remaining policemen had hurried up the steps to what was clearly a covered altar by the time Smith reached it. Cords fluttered as the canvas roof was gathered within the screen of hoardings built on a base of stone blocks. Something mechanical purred and paused. Sparks hissed about the power line strung to the platform along a line of low posts on the western edge of the Assembly.

"On up," Carter said, smiling. He tweaked Smith's manacles toward the steps. The guards were taking position at the base of the altar, facing out toward the Assembly. Despite the siren calls, there was no sign of life or movement from the smelter and its associated buildings. Their blank walls were more than a physical reminder of the grip the freeholders of Moseby held on the minds and lives of those who would work in their village. The business tonight was no business of a bargee or a factory hand.

Smith mounted the steps. Two policemen received him, holding their rifles by the pistol grips as if they were still functional weapons. Well, perhaps they were.

There were other improbable things in this place.

The moonlight was shadowed by the flimsy walls. It gave only hints of the enclosed area: the policemen in their ragged uniforms; two large vertical cylinders, the one mounted somewhat higher than the other; and at the front of the platform, a wooden block the height of a man's knee.

"There," muttered one of the policemen, guiding the traveler's neck onto the block. No force was necessary. Smith was as docile as a babe at its mother's breast. Carter took a quick lashing from Smith's right wrist to a staple set for the purpose in the flooring. "If it wasn't that you know too much," the policeman said conversationally, "we'd let you spend the rest of your life inside the plant. But somebody who's traveled as you have, seen what you have . . . we don't want to be like Samson, chaining you in the temple so you can bring it down on us, hey?"

"Tie him and we'll get this over with," the chief growled.

Carter unlocked the manacles and bound Smith's left wrist to another staple. "It was a good idea when they chopped a few minutes here every week," he said. "It's a good idea now. The ceremony reminds us all that it's us against the world and all of us together. I'll take the ax if you like."

Smith, facing the panels, could not see the exchange. The air licked his neck and cheek as something passed from hand to hand between the men. "Drop the walls," the chief ordered, "and turn on the light."

The pins locking together the corners of the hoardings slipped out. The panels arced down simultaneously in a rush of air and a collective sigh from the Assembly. The purring of an electric motor awoke under the platform, rising and becoming sibilant in the absence of competing sound. A taut drive belt moaned, then the moan was buried in a sudden crackle, and white light played like terror across the upturned faces.

Smith twisted his head. The policemen stood in a line across the width of the platform. Carter in the middle gripped the haft of a fire ax; its head was still darkened by flecks of red paint. He grinned at the traveler. Behind the rulers of the village flared another burst of lightning between the static generator's heads: the polished casings of a pair of fusion bombs. No objects could have been more fitting symbolic of Moseby's power. The Van de Graaff generator provided a crude but effective way of converting electricity to light. Its DC motor pulled a belt from which electrons

were combed into one bomb casing. The static discharges to the grounded casing were all the more spectacular for being intermittent.

"You still have a chance to save yourselves if you let me go," said Smith, shouting over the ripping arcs. "There is no punishment too terrible for men who would use atomic power again, but you still have time to flee."

Carter's smile broadened. His teeth flickering in light reflected onto his face. He roared, "We dedicate this victim to the power that preserves us all!" and he raised his ax.

"You fool!" the traveler said quietly. He did not try to slide back from the block, even as he watched a multiple discharge strobe the edge of the descending ax. The hungry steel caught him squarely, shearing like a shard of ice through his flesh. His vertebrae popped louder in his ears than the hollow report of the blade against the wood. The ax head quivered, separating all but a finger's breadth of the traveler's neck. He blinked at Carter.

The policeman rocked his blade free. Static discharges sizzled behind him at three-second intervals. Smith felt a pulse of warmth as his blast changed flesh knitted together again while the steel withdrew.

Still kneeling, the Changeling turned toward the crowd. "People!" he shouted. "Whatever it costs men today, men tomorrow must know that nuclear power is death! It made this world what it is. It is the one evil that cannot be tolerated, ever again. For Man's sake, for the world's—"

Screaming, Carter slammed the ax down on the traveler's temple. The blade bit to the helve. Smith reached up with his right hand, tearing the staple from the flooring. He gripped the wood, and it splintered as he drew the ax from where it was lodged in his bone. The Changeling stood, his head flowing together like wax in a mold. His left wrist re-formed as the rawhide ashing cut through it.

Sparks like shards of sunlight clawed through the high windows of the power plant. That gush of light died. The siren began to wind, higher and higher. The motor of the Van de Graaff generator was speeding also; the current that drove it no longer controlled. The arcs were a constant white sheet between the bomb casings. Someone—two figures—crossed the bridge from the power plant. The blue glow from the building backlighted them.

"Flee!" Smith cried, lifting to the crowd the scarred hand he had thrown up two centuries before to the flare of a hundred-megaton bomb. "Flee this abomination before it devours you—as it surely will as it did the world before this world!"

Carter screamed again and struck with his rifle butt, hurling the Changeling off the platform. Smith picked himself up. The guards backed away from him, their eyes wide, their cocked bows advanced as talismans and not threats.

The two figures on the bridge threw back their cloaks. The lapping arcs played across the half of Kozinski's face and torso that was naked bone. The bare organs pulsed within, and his one eye darted like a black fly. The blast had sometimes preserved and had sometimes destroyed this once; it had done both in near equality.

Ssu-ma would have stood out without the artificial lightning. She had the same trim, beautiful figure as the girl she had been the night she stared into the sky above Lop Nor and saw dawn blaze three hours early. Now that figure shone blue brighter even than the spreading fire that ate through the wall of the power plant behind her.

The crowd was scattering toward homes and toward the river. No one approached the platform except the two Changelings walking toward their fellow.

The chief threw up his revolver and snapped it three times, four and at the fifth attempt an orange flash and the thump of a shot in the open air. Five of the policemen were triggering their automatic weapons

"She screamed and pointed. Others leveled their weapons. . . Ridges of gnarled flesh stood out as if they had been paraffin refrozen a moment after being liquefied."

and tugging at the cocking pieces to spill misfired rounds on the platform. But the old guns could still fire. Shots slapped and tore at the night in short bursts that pattered over the flesh of the Changelings like rain drops on thick dust. And still they came, walking toward Smith and the platform.

Incredibly, the antitank rocket ignited when the sixth policeman tugged its lanyard. In ignorance he was holding the tube against his shoulder like a conventional weapon. The back-blast burned away the man's arm and chest in a ghastly simulacrum of Kozinski's mutilation. The rocket corkscrewed but chance slammed it into Ssu-ma's chest. The red blast momentarily covered the Changeling's own fell glow. Her body splattered like the pulp of a grapefruit struck by a maul. Simultaneously the front wall of the power plant tore apart, snuffing the arcs dancing madly between the bomb casings.

Then, evident in the sudden darkness, the bits of Ssu-ma's glowing protoplasm began to draw together like droplets of mercury sliding in the bowl of a spoon. Her head had not been damaged. The waiting eyes smiled up at the platform.

Only Carter still stood before the casings. He had thrust the muzzle of his M16 into his mouth and was trying to fire the weapon with his outstretched finger. The round under the hammer misfired.

The power plant exploded again in a gout of lava that loosened the hills deep beneath it and sprayed the village. Wood and cloth began to burn in a pale imitation of what was happening across the creek. In sagging down, the reactor was fusing the rock and the hulls of the remaining bombs. Plutonium flowed white-hot with its own internal reactions, but it was spread too thin to self-trigger another blast. The creek roared and boiled away as the rain of rock and molten metal spewed into it. The vapor that had been a plume over the power plant was now a shroud to wrap the burning village.

"I hadn't called you yet," Smith said, shouting over the tumult as he clasped Kozinski's hand with his own left hand. He extended his right to the smiling Ssu-ma.

"We heard the siren," the Ukrainian said, his voice strange for coming from a mouth that was half bone, the half that had been turned away from the Strike that vaporized his infantry company, he had once explained.

"We could all tell they weren't burning coal, couldn't we?" Ssu-ma added.

The three travelers began groping through the night through the smoke and the screaming. "I don't think we've ever checked whether the Oconee plant was still operable," Smith said. "It'd be a good time to see."

Kozinski shrugged. "We ought to get back to England some time. It's been too long since we were there."

"No, there's time for that," Smith argued. "Nobody there is going to build a fission plant as long as there's one man left to tell what we did when we found the one at Harewell."

A pair of burning buildings lighted their path, sweeping the air clear with an angry updraft. Kozinski squinted, then reached out his hand to halt Ssu-ma. "Your birthmark," he said, pointing to the star-shaped blotch beneath the girl's left breast. "It used to be on the right side."

She shrugged. "The rocket just now, I suppose."

Kozinski frowned. "Don't you see? If we can change at all, we can die someday."

"Sure," Smith agreed. "I've got some white hairs on my temples. My hair was solid brown the . . . when I went to New York."

"We'll live as long as the world needs us," Ssu-ma said quietly, touching each of the men and guiding them onward toward the trail back through the mountains. The steam and the night wrapped them, muffled them. Through it her words came. "After all, what sort of men would there be in the world if it weren't for men like us?"

And all three of them spoke the final line of the joke, their voices bright with remembered humor: "Men like us!"

FUTURE GENDERS

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In her 1979 book *The Transsexual Empire: The Making of the She Male*, Dr. Raymond argued that transsexual surgery is nothing less than an antisocial activity that promotes the worst aspects of patriarchal society by encouraging adaptation to its sex roles." Because transsexualism so emphasizes a dichotomy between women and men, it "constitutes a 'sociological program' that is undercutting the movement to eradicate sex-role stereotyping and oppression in this culture."

She singled out John Money for having contributed "a pseudometaphysics" in transsexualism's defense: "a new theory of the social nature' of sex role differences that's just as immutable (and absolute) as older biological natural law theories." Raymond cites as an example Money's view that gender identity is irreversibly fixed by the age of about eighteen months.

Up to a point, Money agrees. "You can't ignore the fact—if you want to say it this way—that a sick society produces transsexualism, or any other sexual problem," he says. "But you can't simply say 'To hell with all these poor suffering individuals. I'm going to clean up the society first.' You do both together, don't you? The sin is that you would just keep on treating the suffering while at the same time you endorse the perpetuation of the society that creates it."

He does not intend, Money says, to endorse the perpetuation of that society. "The whole purpose of paying attention to transsexualism is to force society to change its entire attitude toward, for instance, the sex education of its children, and its attitude toward normal premarital sexual rehearsal play in infancy."

Children's sexual rehearsal play is a topic about which Money may be more zealous than he is about any other subject. Projecting on the classroom screen a picture of young monkeys playing at coital sex, he wonders aloud, "If sexual rehearsal play is so essential to psychosexual normalcy in these young monkeys, then what on Earth is it that we're doing to our children by prohibiting and punishing sexual rehearsal play?"

"I think that we produce all the psychosexual disorders, all of the sex offender disorders that get people thrown in jail, because instead of encouraging children to develop normal heterosexual play patterns, we encourage them to develop no sexual play patterns at all. That's a hypothesis that cries out for further research, which I suppose one day will be done," he tells his class as he projects slides taken secretly by telescopic lens of a boy, about five, with his pants down, mounting a girl slightly younger.

Money's emphasis on "copulatory sexuality" stands in sharp contrast to his own remarkable vision of the variety of human sexedness. It suggests that, like the society around him, he is committed to maintaining the social division between people, with the act of coitus as the bottom line. Unlike society at large, however, Money recognizes that none of the apparent differences between humans really justify an absolute division of the human species into two sexes. But like society, Money has chosen anyway to divide people by a single variable: the presence of a penis large enough for intercourse.

So where do John Money's insights lead? What's the future of human gender identity? "I would don't want to be dogmatic about it," he says, "but I think the evidence rather strongly suggests that if you have a society in which there isn't a hangup about children's sexual rehearsal play, you're going to cut down on the developmental differentiation of gender-identity disorders of every type."

Would a society that is less hung up on the separation between "male" and "female" have the same advantage?

"Well," he replies, "I don't think that particular thing alone—what do you want to call it? the androgyny factor—necessarily has much to do with it. Androgyny doesn't do away with penises and vulvas, does it?"

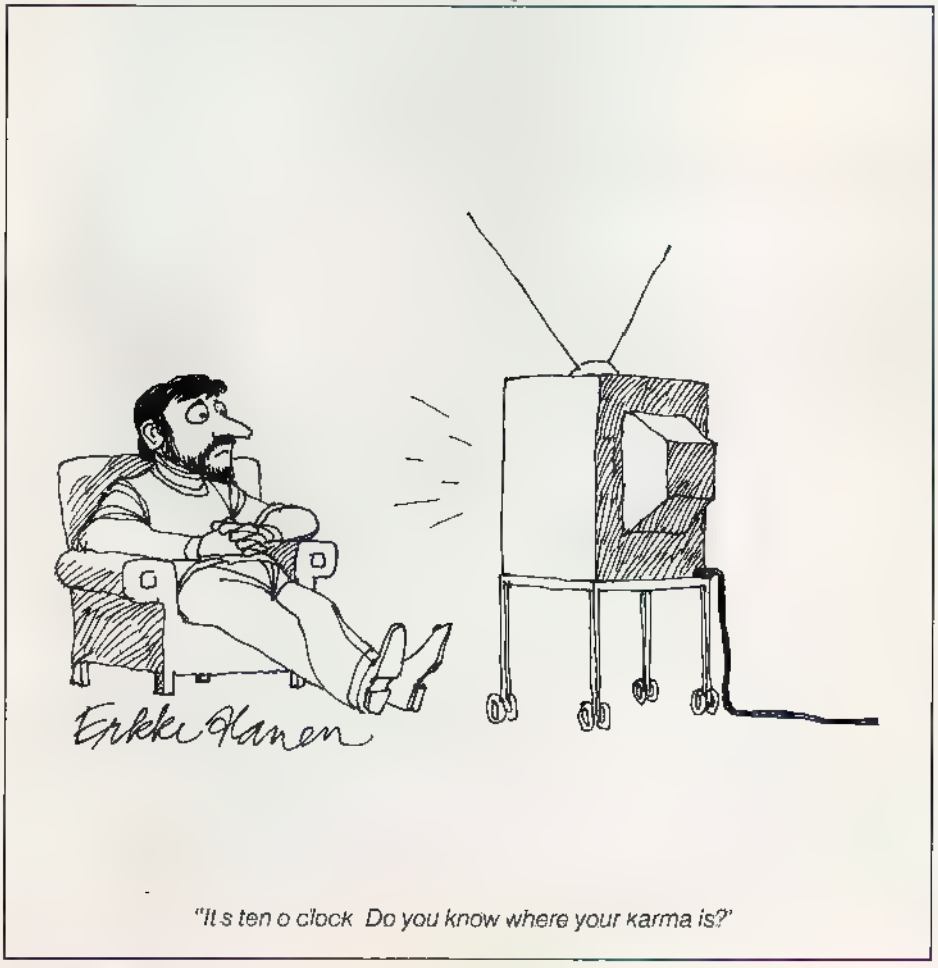
Science, however, may at least as a fixed part of our lives.

Johns Hopkins, the site of Money's first sex-change operation, decided in mid-1979 to stop performing the surgery, in response to a study by psychiatrist Jon K. Meyer. Meyer found that there was no appreciable difference in "adjustment" between patients given the operation and those who applied for a sex change but never got one.

Even before that, however, Money stated, "I don't think sex-reassignment surgery with hormone treatments will continue to be the method of choice for treating transsexualism. There's going to be such an explosion of knowledge of how the brain works—about the physiology and transmitter chemistry of pathways that mediate sexual function and identity—that there's no limit to the science-fiction things we will be able to do."

In his class, he describes the cleaner fish, a species that can change its reproductive sex. "There will come a time when biologists figure out the endocrine and cellular mechanism by which that sex change takes place," he predicts. "Once the biochemistry is understood we'll figure out how to do it in mammals. The next step will be to do it in human beings. And transsexuals would be profoundly grateful if you could bring about that kind of change of sex—a change in fertility and breeding power, too."

Will our multisexed nature then find expression sensually and societally? Ironically, Dr. John Money, the man who revealed how astonishingly varied human sexuality is, cannot see where his discovery leads. ∞



"It's ten o'clock. Do you know where your karma is?"

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INTERVIEW

CONTINUED FROM PAGE 90

what's growing, and what has real potential. Those can go on a new S curve, but in a completely different place.

Omni: Will we have a multieconomic phoenix rising from the ashes of Keynes and his theories?

Henderson: Yes, I think so. The main body of traditional economic theory can help with quantifying all of our social costs. But it will finally bog down when the understanding dawns that all economics was ever concerned with was the monetized sector. Economists were hypnotized by this abstraction called an *economy*, while there's really no such thing as an economy; there's a sociotechnical system embedded in an ecosystem.

Omni: How will problems affecting the industrial nations affect the Third World?

Henderson: The Third World has been caught in the same debate between capitalism and Marxism that has occupied the Northern Hemisphere over the last several decades. They have two very clear examples: the apparent—almost hypnotic—successes of the West, and the Marxist way, which clearly points out the anomalies of the Western way of life. Most Third World leaders now seem to be talking of a third type of approach, perhaps something like Sweden, which has a very ingenious mix of private enterprises and public controls. They are looking to pick and choose the best from both worlds—to see where the rubber really hits the road—and create something that fits into their own cultures.

Omni: Could technology assessment help us cross the barriers we've been talking about? Turn everything around, so to speak, and plant the seeds to get the flowers bloom?

Henderson: I think that it has enormous potential. I've been on the Advisory Council of the Office of Technology Assessment ever since it began six years ago. I saw that technology assessment used an integrated, interdisciplinary approach with economics only one part of a much larger patterning of problems. There was tremendous potential for remapping the situation in such a way that we could come up with all kinds of innovative policy alternatives. Today policymakers are stuck with using old maps to define the 'problems' in the same old way, which means they are going to keep redoubling their efforts to do the old thing that already failed. The alternative is to put on a different pair of disciplinary spectacles and see a new pattern and reconceptualize the problem—or even discover that it isn't the problem at all.

The Office of Technology Assessment is one of the few governmental agencies where that questioning and the reconceptualizing have been institutionalized. One of the ways that I tried to open OTA's conceptual approach was to insist that persons and groups in society affected by various technological choices—but not necessarily benefiting from them—be included as representatives on the advisory panels for such studies along with persons possessing the more traditional kinds of expertise. Yet this information on impacts requires a very real sort of expertise: it's social feedback, or anticipatory social "feed forward."

This "early warning" creates a better definition of the problem. I just find the inclusion of people who don't have orthodox degrees, such as consumer and labor representatives and environmentalists. Their experience is vital to securing a definition of the problems.

Omni: Will these people have less of a sense of isolation from the people defining the problems?

Henderson: Yes. You see what happens is the people from the traditional disciplines—the physicists and the engineers and the economists who normally have been involved, have been isolated and have a sense of unreality of how these technological ideas really impact on human beings in real situations.

Omni: Would it be mainly because they're not quantifying the things we've spoken of, like bioproductivity?

Henderson: Right. Those old disciplines are too specialized and do not include the second- and third-order consequences. We had a terrible problem when OTA started in that so many of the contractors who came in were just putting old wine into new bottles. They would come in and swear on a stack of Bibles that they knew how to make technology assessments. But when you really unraveled it and you examined their assumptions, you'd find that what they were talking about was technological and economic feasibility, which is very different. That's not technology assessment at all.

It's very unscientific to look at a problem and then jump to a methodological conclusion or not even to think about the method that you're going to use. There's no justification to using cost/benefit analysis merely because that's the thing that you happen to be trained in. A good technology assessment examines real world problems case by case and says: "First, there's the technological feasibility and first-order consequences of going in this direction. Then there are the second-order problems when a technology diffuses. What happens when it is used in an institutional framework of commercialization? What kind of problems does that create?"

You need to synthesize the answers to these questions, and whatever environmental, health, and safety impacts there may be, using four or five different models and methods. That's one reason why the advisory panel should incorporate people with all kinds of viewpoints and biases. Some will have a physics bias, some an environmental, and some an economic or social perspective. We've learned that there's no such thing as "objective" science or value free technology. ∞

BRAIN WARS

CONTINUED FROM PAGE 47

out of thousands of dollars in prizes, all of which later were donated to charity and to refurbishing the dorms. Honoring the hamburgers' brilliance, a delighted rival Burger King awarded the intrepid students a $3,000 scholarship for their school.

But the proudest moment in the history of Caltrickery, the most sublime of all student pranks, is certainly the Great Rose Bowl Hoax of 1961, pulled off during Pasadena's most sacred civic event and witnessed by millions on national television.

The stunt was conceived by bored students in Lloyd House dorm during Christmas recess. The first step called for a student, disguised as a high-school reporter, to conduct a lengthy interview with the flattered student director of half-time events for the University of Washington, a Rose Bowl contender that year.

The student quizzed the unsuspecting director on how the planned card stunts were arranged and later managed to make off with one of the instruction sheets. Back at Caltech, the students worked night and day, meticulously reworking and counterfeiting all 2,300 instruction cards. On New Year's Eve, a commando team broke into the director's hotel room and pulled the switch.

At halftime of the Rose Bowl game, the cocky Washington card section went through their first nine stunts without a hitch. On the tenth, the director called for "a big Washington," but, to his amazement, the cards came up "Caltech." Nonplussed, he hurriedly ordered the next trick, which was to spell "Huskies" slowly across the section. It came out "Seikstuh." The director became frantic and called for the next sequence, a picture of the Washington Huskie mascot. Up popped a leering Caltech beaver, and all semblance of order was lost as the shattered card section gave up. It was a shame, for the next trick, a patriotic appeal to 'Buy Bonds,' had been transmuted into "Buy Blondes" by the Caltech students.

It's noon, and reports are flooding in from the field that more senior stacks have joined the growing casualty rolls. Pykas room was broken into hours ago, and a counterstack is already in progress.

In another dorm, Aristotle the snake is gingerly lowered on a sling through the transom into the room. The snake responds beautifully and wraps himself around a box containing the key. He's pulled back through the transom, and another finesse stack bites the dust.

The Blacker beer bottle laser stack is declared OUT OF ORDER while smoke fills another dorm corridor. Several wimps try to scotch a fire caused while they attacked a heat-seeking finesse stack. An enthusiastic sophomore had poured hot wax into the lock, unintentionally setting fire to a pile of underwear on the other side of the door.

When they encounter a prank, the good gray heads of Caltech's professors only nod appreciatively. They can hardly criticize, having engineered stunts as wild as any dreamed up by their students. Richard Feynman, theoretical physicist and Nobel laureate, is also a bongo drum player and master safecracker. While working on the Manhattan Project, developing the A-bomb, Feynman practiced on safes, leaving "Guess who?" notes among the top-secret papers.

Another faculty member, Harry "The Horse" Gray, is a brilliant chemist and bon vivant who frequently enlivens his complex lectures by delivering them in, would you believe, a horse suit.

How does all this eccentricity sit with Caltech President Marvin L. Goldberger? A respected physicist, he possesses a dignified carriage, a proud profile, and a mane of white hair that would be the envy of any senior statesman. However, the good doctor is well suited for the job of tracking the strange orbits of Caltech's students. He, too, has that Wizard of Oz sparkle in his eye. The students recognized it immediately after his arrival last year from Princeton, and they saluted him by tossing him into the Pacific Ocean. Not to be outdone by the informal welcome, Dr. Goldberger later made his own entry into Caltech legend.

"The FBI was called in when it was learned that Caltech students were tapping the professors' phones. . . . Actually the undergrads had tapped the Strategic Air Command hot line."

To celebrate Einstein's hundredth birthday, President Goldberger donned a riding habit and pith helmet and triumphantly piloted a rented elephant along the same campus walks where the gentle Einstein had wandered on his visits. Later, wielding a saber and with a samurai yell, Goldberger expertly slashed into a three-tiered birthday cake.

All are agreed that the master faculty jokester is the puckish Nobelist Murray Gell-Mann, the theoretical physicist who bestowed the unlikely name *quark* on nature's fundamental unit of matter. From now into infinity, whenever sober physicists gather to discuss the serious business of the nature of the universe, they will be required to make a sound not unlike a lovesick stork.

By 4:00 PM, most of the stacks have been either broken into or broken down. Isolated knots of frenzied undercassmen are working to beat the clock on the remaining puzzles. Outside Page House the crisp pop of a .22 rifle is heard as wimps, posted on an adjacent roof, fire into an open window, striving to hit the more diverting parts of another *Penthouse* centerfold breaking circuits that will spring the lock.

In another dorm three wimps are locked in mortal combat with a computer console, battling an intricate program that requires them to enter a series of mythical caves where they face an electronic monster named Ork. Two wimps can only watch, having already been "devoured" by Ork.

As each stack is liberated, the group in front of Barbara Hsu's room grows. Above her door a transom has been converted into a three-dimensional maze with 60 interconnecting coded compartments. With only three obscure modern poems providing clues and with a little white mouse occasionally appearing at the openings, the wimps deduce they have to force the mouse into one compartment, which will close an electrical circuit and open the door. But which compartment? If the mouse knows, he's not talking. Nor is he cooperating, having eagerly accepted the numerous bread bribes the wimps have offered only to retreat into a back corner of the maze and promptly fall asleep.

An impenetrable web of thousands of feet of string will greet another returning senior while Cohn, senior class president, will discover his new roommate—a 1,000-pound rock sculpture carted gleefully away from a formal garden.

Pyka's room is researched with enough steel to build an aircraft carrier and decorated with the immortal words Caltech students share with every other college student: "Eat it, Werner." Once inside, Pyka will also discover 400 cases of bottles filled with water. But he'll have to drill through the wall and crawl through a dresser drawer to get in.

No one is quite sure why Caltech developed into such a den of tricksters. Some say it's a fusion of the students' natural brilliance and California's nutbal tradition. Others claim that confronting challenges like Ditch Day is a worthy part of the students' training, like a lion cub engaging in mock combat. When they graduate to become full-fledged tollers in the halls of science, they may be inspired in their efforts by remembering, "Once there was this door."

Ditch Day is over, and the young prodigies are weary from their mental workout, but you'll hear from them again if not directly, then indirectly through the machines they'll build to keep our technological society afloat. After all, anyone who can break into a complex finesse stack can surely solve small problems like the energy crisis, Three Mile Island, or a falling *Skylab*.

However, they *were* stopped cold by a mouse. ∞

LOOKING TOWARD SPACE

CONTINUED FROM PAGE 58

today and run the risk of being abused

But also believe that there are moments in history when challenges occur of such a compelling nature that to miss them is to miss the whole meaning of an epoch Space is such a challenge It is the kind of challenge William Shakespeare sensed nearly 400 years ago when he wrote

There is a tide in the affairs of men
Which, taken at the flood leads on to fortune,
Omitted, all the voyage of their life
Is bound in shallows and in miseries
On such a full sea are we now afloat,
And we must take the current when it serves
Or lose our ventures

We risk great peril if we kill off this spirit of adventure, for we cannot predict how and in what seemingly unrelated fields it will manifest itself. A nation that loses its forward thrust is in danger, and one of the most effective ways to retain that thrust is to keep exploring possibilities The sense of exploration is intimately bound up with human resolve, and for a nation to believe that it is still committed to forward motion is to ensure its continuance

I doubt there is a woman or a man who honestly believes that the United States could ever fall backward as other nations have within our lifetime. Intuitively we feel that we are exempt. Yet for us to think so is to fly in the face of all history, for many nations at their apex were inwardly doomed, because their willpower had begun to falter, and soon their vulnerability became evident to all Enemies do not destroy nations time and the loss of will bring them down

Therefore, we should be most careful about retreating from the specific challenge of our age We should be reluctant to turn our back upon the frontier of this epoch Space is indifferent to what we do, it has no feeling no design, no interest in whether we grapple with it or not. But we cannot be indifferent to space, because the grand, slow march of our intelligence has brought us, in our generation to a point from which we can explore and understand and utilize it. To turn back now would be to deny our history, our capabilities

I was not overly impressed when men walked upon the moon because I knew it to be out there at a specific distance, with specific characteristics, and I supposed that we had enough intelligence to devise the necessary machinery to get us there and back But when we sent an unmanned object hurtling into distant space and when it began sending back signals a chain of numbers to be exact that could be reassembled here on Earth to provide us with a photograph of the surface of Mars, I was struck dumb with wonder And when computers began adjusting the chain of numbers, augmenting some diminishing others so that the photographs became always clearer and more defined realized that we could accomplish almost anything out in the farthest reaches of space

My life changed completely on the day I saw those Mars photographs, for I had participated in that miracle My tax dollars had helped pay for the project The universities that I supported had provided the brains to arm the cameras And the government that I helped nourish had organized the expedition. I saw the universe in a new light and myself and my nation in a new set of responsibilities My spirit was enlarged and my willingness to work on future projects fortified

No one can predict what aspect of space will invigorate a given individual, and there must have been millions of Americans who did not even know Mars had been photographed But we do know that in previous periods when great explorations were made they reverberated throughout society. Dante and Shakespeare and Milton responded to the events of their day Scientists were urged to new discoveries And nations modified their practices in accordance with these discoveries

All the thoughts of men are interlocked and success in one area produces unforeseen successes in others It is for this reason that a nation like ours is obligated to pursue its adventure in space I am not competent to say how much money should be spent I am not competent to advise on how the program should be administered But I am convinced it must be done

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TIME MACHINE

CONTINUED FROM PAGE 94

clude that nature will not form such mass configurations; so, they reason, time machines are impossible. Yet when you read the papers, you find that they use assumptions such as "realistic collapse," "normal matter," and "stable configurations," loopholes large enough to build a time machine in.

There are many things in our world that are not in a "realistic" or "normal" or "stable" state of nature. A transistor is an unnatural miracle—an ultrapure silicon crystal. A liter of liquid helium, a purebred poodle, a laser, a geosynchronous communications satellite—all are "unnatural" oddities kept stable by their human makers.

This is an uncomfortable situation for theorists, as a recent statement published by Dr. Frank Tipler makes clear.

In 1974 Dr. Tipler pointed out that "general relativity suggests that if we construct a sufficiently large rotating cylinder we create a time machine."

Three years later he proved that you could not build a time machine with "normal" matter—matter that did not reach black-hole densities. Tipler concluded his second paper with the deliberately pontifical statement: "The demonstration that no possible combination of known substances, known forms of machinery, and known forms of force can be united in a practicable machine by which men shall [travel back in time] seems to the writer as complete as it is possible for the demonstration of any physical fact to be."

This quotation is a slight modification of a similar statement published by Simon Newcomb in 1906 at the conclusion of his classic paper demonstrating the impossibility of heavier-than-air flying machines. Newcomb had been proved wrong even before his statement reached print. One feels that Tipler has deliberately hedged his "impossibility proof" with the form of his conclusion.

It may be true that nature will not form a Kerr metric time machine from a collapsing star. But with a little guidance from our far-future descendants, a star bigger than our sun might be made into a ring-shaped time machine—100 kilometers in diameter—and be maintained even though it could not be stable if left alone. This time machine would be big enough and safe enough to send an entire rocket ship, and its passengers, back in time.

Some physicists object that the Kerr metric solution requires the mass in the spinning ring to move at the velocity of light, and this can never be attained. Yet other solutions have shown that the speed-of-light requirement is slightly relaxed if the mass also carries an electric charge.

But the debate about the Kerr time machine is not that important. A spinning ring is not the only shape for a time machine. The Kerr metric has the theoretical advantage of being a complete solution to the full Einstein equations. However, there are many, less rigorous solutions to Einstein's gravity theory that offer us possible designs for a time machine.

Another configuration for a time machine is the spinning cylinder described by Tipler in 1974. The theoretical model for this time machine uses a mathematical approximation, so it is not as rigorous as the Kerr model. Theoreticians find it easier to attack. But any electrical engineer can attest that the approximation works well in electromagnetic theory. It should work equally well in gravitational theory.

Tipler's time machine is a long, ultradense, rotating cylinder with a spin speed at its surface one half that of light. In this design, time becomes distorted near the cylinder's midpoint but outside its mass. To travel through time, you simply orbit the cylinder halfway along its length. The important feature of the Tipler two-way time machine is that it allows travel both backward and forward in time (depending upon whether you circle with or against the spin of the cylinder). Neither the time traveler nor the time machine has to move at velocities close to that of light.

So we cannot rule out the possibility of building a time machine based on our current understanding of physics. In fact, it seems quite likely that we will eventually build one.

If we can travel back and forth in time, though, what seem to be real paradoxes arise. We'll be spared one version of this famous problem. According to Einstein's laws, time machines can take you backward in time only to the moment when the machine was turned on and forward only to the moment the machine is turned off. A future time-machine maker will not be able to go back in time and tell himself how to make the machine.

But this kind of paradox takes other forms. Exhuming an old cliché: "Why couldn't you go back in time and kill your grandfather before he had any children?" These paradoxes all boil down to a violation of a strict, time-ordered, cause-and-effect relationship. There are those who would argue that this is enough. The very fact that causality would be violated means that time travel is impossible, nothing more need be said.

Yet we learned to accept the truth of Einstein's special-relativity mathematics despite its insistence that time was not the same for all but could be stretched and compressed. In the future we may adjust to Einstein's general-relativity mathematics, which says that time can also be made to run backward.

I don't know the solution to the logical paradoxes presented by time travel. I suspect that we shall be forced to concede that time order is not absolute but can vary according to our experiences with time vehicles, just as we were forced to accept that

time rate is not absolute, but would change dramatically for passengers in a space vehicle traveling near the speed of light. Once a time machine exists, then decisions made at one point in the time line of an individual can affect not only the future but the past.

In our example, President Greatman made the decision to send a message back in time. That decision set off a chain of events that warned him in the past that a catastrophe was about to occur, allowing him to evacuate the east coast of the United States before a meteor struck. The decision "caused" the evacuation "result" to occur "before" the "cause." Yet from a logical viewpoint that neglects temporal order, the evacuation "effect" was a direct consequence of the decision "cause", the causal "impulse" just happened to be transferred by a message that moved backward in time.

It may be tens or hundreds of thousands of years before the human race has evolved to the point where we can control collapsing stars in order to make a time machine big enough for a vehicle loaded with human travelers. Long before then, however, we may be able to make miniature time machines. This would be enough to allow messages encoded on pulses of laser light to be sent backward and forward in time.

If we took the mass of an asteroid, around 15 billion metric tons, and compressed it enough to unhinge time in a small region, it would have the dimensions of an atomic nucleus—a superheavy superdense nucleus. Strong electric, magnetic, and radio fields would be needed to keep it evitated, elongated, and spinning at the proper speed.

The laser messages shot into it would have to be made of extremely short pulses of gamma rays with wavelengths smaller than the time-transfer region. A message would consist of a small number of gamma rays, each at a slightly different frequency corresponding to its "code word" in the message. At these high energies, gamma ray detectors are highly efficient, so decoding the cluster of photons that had emerged a few weeks in the past would be relatively easy.

The gravitational field from a 15-billion-ton mass at ten meters distance is about one Earth gravity. If the time machine were enclosed in a 20-meter sphere, there would be two Earth gravities on its top, zero gravity underneath, and 1.414 g's tilted at 45 degrees at the equator.

These time machines could exist within 100 years if there are breakthroughs in our understanding of elementary particles and ultradense matter. Some of us now living may eventually owe our lives to the warnings brought to us from the future by these "impossible" paradox producers. After the crisis is over and we have time to reflect, we will wonder about those ancient philosophers who were so worried by those "time machine paradoxes." ∞

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JOSIE AND THE ELEVATOR

CONTINUED FROM PAGE 52

denly become drastically unhappier. Josie never suspected that she was in her. At school she was always made to sit in the front row. Her teachers were boring, stupid, and either weepy or very mean. Her classmates teased her mercilessly for being fat. At home her father ignored her, and she spent her afternoons and evenings alone watching mind-numbing programs on television and eating junky desserts, which made her still fatter. These desserts were poisoned, as all the food in hell is poisoned, so that when she was in school she couldn't think clearly. She flunked fourth grade and seventh grade, too. By this time her father had become an alcoholic. He and Josie moved to a cheaper apartment, in a neighborhood where muggers abounded and where even on summer afternoons it wasn't safe for a child to go outside to play. No longer could Josie brag about having her own bathroom or even her own bedroom, for the room she had to sleep in now was also a kind of office. There was an awful stench in the kitchen that never went away.

Josie became a teenager, and then a grown-up, and each year was more dismal than the year before. But really there's no need to go into too much detail. Enough to say that by the time she was twenty-four she had been married three times and raped twice—once, when she was fifteen, in the locker room at her high school and the second time, when she was twenty-two, by her first ex-husband, who almost killed her. She had also attempted suicide twice with pills, but in hell suicide attempts are never permitted to succeed. Otherwise everyone could just kill himself and be done with it.

Despite everything that had happened to her in hell, Josie still somehow believed there was a way things might get better. She believed, in the words of one of her favorite songs, that *somewhere* there was a place for her, a place she could at last be happy in. But where? She would never have believed that that happier place was no farther off than the other side of town, for by now she'd forgotten everything that had passed between her and the elevator, the way you forget the things that happen in nightmares. In hell there are so many nasty things happening all the time that if you kept track of every one of them, you'd soon go quite insane.

That, in fact, is what had happened to Josie's mother in Boiza. First she had come down with infectious hepatitis; then, while she was recovering from that, something went wrong inside her head and she was able to see all hell's usually invisible devils. For years she was confined to mental hospitals, jeered at by these devils the way poor Josie was jeered at by her classmates. Even in our world mental hospitals are nowhere anyone would want to live, but in hell, naturally, they're much, much worse. Nevertheless, one day Mrs. Hardwinter's insanity disappeared as inexplicably as it had come. That is to say, she stopped being able to see the devils around her. After she'd convinced the examining doctors that she wasn't crazy anymore (which took rather a long while), they let her out of the hospital. Having no other idea where to go, she returned to the apartment building where she used to live and asked whether there was an apartment she could rent. Since the building was scheduled to be demolished in two more years (the renting agent didn't mention this fact to Mrs. Hardwinter), there were several vacant apartments to choose from, and so, twenty years after she'd left it, Mrs. Hardwinter returned to apartment 13-D.

When Josie received her mother's postcard inviting her to visit her at the old address, her first reaction was simply to be furious. The nerve of her after running away and leaving her with her old soak of a father! After twenty years of almost unbroken silence. (There had admittedly been Christmas cards—for even in hell one is obliged to send Christmas cards.) After locking her out of the apartment without her shoes! (Josie had come to believe her own long-ago lie.) To send a *postcard* after all that! "I'll send *her* a postcard," she thought aloud. "See how she likes *them* apples!"

"She knew that her life had become, all of a sudden, drastically unhappier. . . . At school she was always made to sit in the front row. Her teachers were boring, stupid, and either weepy or very mean."

But then (for Josie was leading a very lonely life in hell) she decided after all that a single visit could do no harm. Her mother might actually have become a nice person. If she hadn't, Josie would at least have the satisfaction of telling her off. So donning her brightest pantsuit and arming herself with a purse containing a spray can of Mace (a standard precaution in hell), Josie set off on the number 12 bus and arrived in her old neighborhood in a little less than an hour.

The years had not been kind to the old apartment building. Its stone doorway had been vandalized, and its remains were covered over with yellow formica, part of the decoration of the pornography shop that had moved in on the ground floor. The buzzer system didn't work, and inside the lobby half the mailboxes looked as if they'd been broken into. The aluminum ashtray had disappeared, and now the floor was littered with butts.

Graffiti covered every surface with irrefutable evidences of the hatred, lust, and imbecility so prevalent in hell.

Josie regarded the elevator button doubtfully, unable to believe that in such a derelict building the elevator might still be working. But even in hell one hopes against hope. She pressed the button and, oh and behold, there was a rattling of chains and then a long, deep groan, and the doors of the elevator opened.

Suddenly it all came back to her—everything the elevator had said to her and how she had replied. Her rudeness, her cruelty, the broken mirror.

"Oh, elevator!" she cried out, falling to her knees and pressing her hands and then her lips to the scuffed, unswept linoleum tiles. "Elevator! Dear elevator, I'm sorry! I'm so sorry. Please, please forgive me! I'll replace the mirror I broke. And I'll keep you clean. And—And I *promise* never, never to do such a terrible thing again."

Without a word (being too moved to attempt a reply) and without waiting for Josie to press 13, the elevator hurtled upwards, up past the boundaries of hell, up past the ground floor of the world above, up in a single glad rush to where Josie's mother lived on the thirteenth floor. There it stopped and opened its doors, and Josie got off with a sense irrational but nonetheless unshakable, that her life had taken a turn for the better.

And of course it had. Josie found that she liked her mother better than she'd ever liked her before, and though Mrs. Hardwinter was a little suspicious at first and inclined to believe her daughter was a little crazy (for she could not be kept from conversing with the elevator whenever she was in it), she eventually came round to liking Josie in return. After all those years in the mental hospital she was inclined to be tolerant toward the kinder sorts of craziness.

They decided to live together there in the old apartment building, which wasn't torn down after all, but was renovated instead. Josie, true to her promise, replaced the mirror she'd broken, and the poor old elevator was so overcome that it was stuck for four days on thirteen. But after the repairman came and tinkered with it, it seemed as good as new.

Josie's life, too, took a turn for the better. With a bit of friendly bullying from her mother she got her weight down to a comfortable hundred thirty pounds. Nicest of all, she found a job that didn't drive her crazy with boredom and paid a decent wage besides. (In fact, she became a teacher, but that is another story.)

All in all, Josie could not complain, or at least she preferred not to. If this wasn't heaven (elevators, alas, cannot go *there*), it was clearly an improvement on hell. ∞

EARTH

CONTINUED FROM PAGE 14

Academy of Sciences in 1974 showed that there are at least several hundred plant species that seem to offer immediate potential for use in relieving hunger and improving nutrition.

In addition, wild species help established agriculture. All conventional crops need to have their genetic constitutions regularly "topped up" in order to maintain, let alone expand, their productivity. The addition of wild germplasm is also crucial in resisting new insect pests, adapting to our changing climatic conditions, and other environmental threats. America is especially dependent on these wild gene reservoirs since much of its agriculture is imported from Europe and Asia.

When a medical prescription is filled at a pharmacy there is a 50 percent likelihood that the medicine is of natural origin. The commercial value of these drugs in the United States alone is put at over $5 billion per year. Nonprescription preparations, similarly derived from wild creatures, are worth another $5 billion.

As for industry, the need for raw materials is growing rapidly as the world's population increases. The energy shortage has prompted Melvin Calvin, of the University of California at Berkeley, to undertake research in plant species that produce hydrocarbons similar to oil.

All in all, the value of foreign supplies of genetic resources to the U.S. economy amounts to $10 billion a year, which is a conservative estimate. However, we are eliminating the very source of our livelihood in little more than the twinkling of an eye, geologically speaking, for this is the greatest biological debacle since life began 3.6 billion years ago.

Extinction is, of course, an overwhelming fact of life. Fewer than 10 percent of all the species that have ever inhabited this planet are alive today. Yet, until now, the world has never seen the broad scale elimination of species to match a rate of one species per *day*, let alone the impending demise of thousands, perhaps millions, of species.

Even the disappearance of the dinosaurs, normally characterized as a "freak dying," occurred at only a rate of roughly one species every 1,000 years. Dinosaur extinction caused only a small proportion of Earth's total complement of species to vacate the scene.

Nothing—*nothing*—in Earth's history matches what is occurring today, both quantitatively and qualitatively. Dr. Thomas Lovejoy, of the World Wildlife Fund, declares: "There have occurred, during the unfolding of life's story on Earth, the Paeozoic, Mesozoic, and Cenozoic eras, the eras of Ancient Life, Middle Life, and Recent Life. In theory we are still in the Era of Recent Life. But perhaps we should declare that era ended and designate a new one, the Era of Life's Impoverishment."

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Designatures II
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COMPETITION

By Scot Morris

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We regret that space permits so few of the 3,000 designatures received to be published. If you like these, watch for an expanded collection in a special *Omni* book we are now preparing. If you're inspired by these designatures to create more of your own, send them in.

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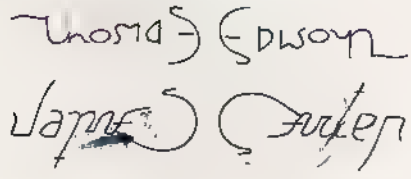
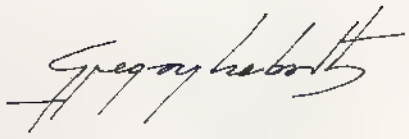


THOMAS EDISON/JAMES CARTER by Eric Tissue, Pittsburgh, Pa.

ASIMOV by Dean Rusk, Brooksville, Fla.

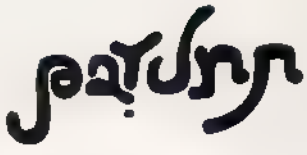
DESIGNATURE by Frank H. DeJong, Huntington Beach, Calif.



GREGORY LEIBOLT, signature by Gregory Leibolt, Chestertown, Md.

JOHNNY CARSON by John Laughlin, Paris, Tenn.

JESUS THE CHRIST by Bill Dunham and Lezli Perkins, Merced, Calif.

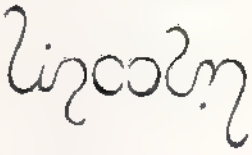


SATURN/JUPITER by Doug Busch, Lansing, Mich.

NIFTY COMPETITION, by Carol Allen, New York, N.Y.

HAPPY BIRTHDAY by Debbie Parker, Eugene, Ore.

LOCH NESS/MONSTER by Ray A. Jorgensen, Las Vegas, Nev.



LINCOLN, by Sandra J. Zack, Cambridge, Mass.

RELATIVITY by B. T. Brame, Eu less, Tex.

FIRST/LAST, by Doreen Michael Langley, B.C., Canada

BLACK/WHITE, by Clay C. Jones, Fort Worth, Tex.

OMNI/FUTURE, by Betty J. Busby, Yorba Linda, Calif.

SPACE

CONTINUED FROM PAGE 22

economically used to support the projects planned by NASA for the 1980s and 1990s. Lunar oxygen could be used as rocket fuel and for life-support systems in space; lunar silicon could be fabricated into solar collectors for satellites, and lunar metals could form the supports and hulls of large space structures. The door to large-scale manufacturing and agronomy in space is likely to open sometime during the 1980s after the space shuttle starts routine flights.

Recent engineering studies have examined the possibility of retrieving Earth-approaching asteroids for space manufacturing. This resource is vast. There are probably more than 100,000 such objects with diameters greater than 100 meters and masses around 1 million metric tons. The unit cost to retrieve asteroids may be many times less than the $1,000 per kilogram lift cost of earthly materials using the shuttle or $1 to $2 for lunar materials. The small asteroids have nearly zero-gravity fields. So the prospect of costly landings is avoided. Solar energy for processing and propulsion is continuously available on the asteroid.

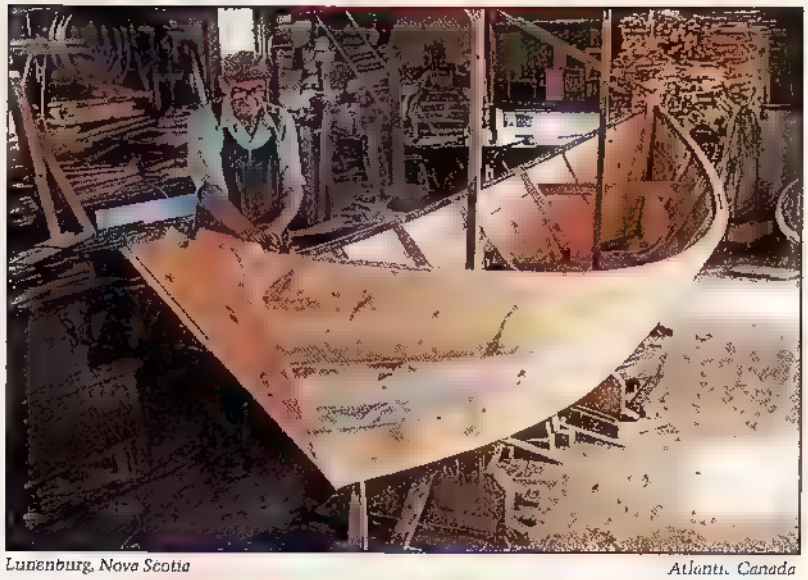
The favorable economics of asteroid retrieval, combined with the apparent attractiveness of space agronomy, raise the possibility that food could be grown more cheaply and more reliably in space than on Earth, given a highly developed program of space manufacturing. Large quantities of dehydrated crops could be dropped out of orbit (possibly by an electromagnetic mass-driver device), enter the earth's atmosphere aboard a metal-foam reentry body, land in the ocean near potential consumers, and be towed ashore for use. Astronomers Michael Gaffey and Thomas McCord have explored similar techniques for recovering asteroidal metals on Earth.

A three-kilometer carbonaceous asteroid towed earthward by a solar-powered mass driver (most of the mass driver mass and expense would go into the power plant and its radiators) could provide enough growing area to support 6 billion people — the projected world population for the year 2000. In the interim smaller asteroids could be turned into smaller growing areas as famine insurance.

A retrieval system would cost in the range of $100 billion to $200 billion, spread over the next 20 to 30 years. This investment compares favorably with the $700 billion it would cost between now and the year 2000 to provide irrigation and to modernize agriculture in the Third World. Given a potential market of $200 billion to $500 billion a year, the payoff would be rapid.

Food production in the United States totals approximately $100 billion. 20 percent of this is exported. Given reasonable productivity in self-supporting space colonies and low-cost transport to Earth, the cost of food product on Earth may be rivaled by the economical breadbaskets of space. ∞

CANADA



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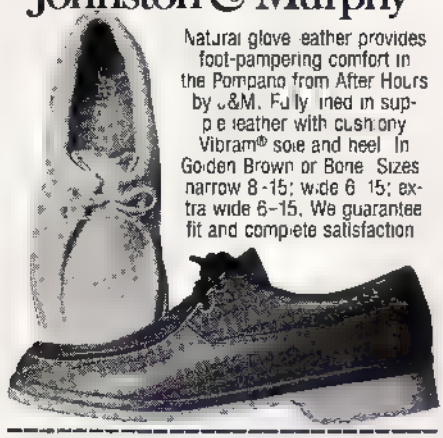

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GAMES

ANSWERS TO GAMES (page 144)

Petals Around the Rose The key is in the name of this dice game. The "rose" is the center dot on a die face and the "petals" are the dots around it. The only faces with a central rose are the odd ones 1, 3, and 5 but only on the 3 and 5 are there any petals around it. The number is the sum of all the petals two on every 3 face and four on every 5 That's all there is to it

STRANGE FACTS

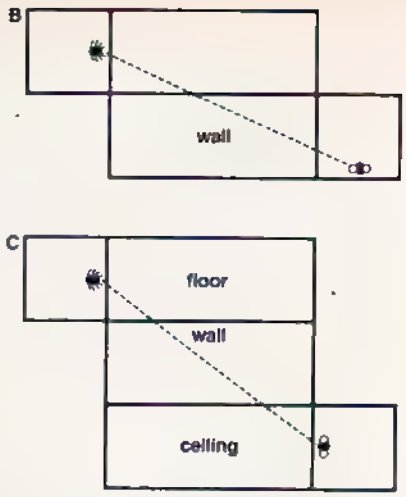
1 *Magic Stuff* Baking soda
2 *French Spread* Margarine
3 *Rare Treat* Blood
4 *Light Fantastic* The glowworm
5 *Moving Easy* A man on a bicycle
6 *Hot or Cold* December The sun is 3 million miles closer to the earth in winter, though the Northern Hemisphere is colder then because the sun's rays strike at a more oblique angle
7. *Commonplace* Eclipses of the sun are more common, but the area of the earth from which they can be seen is usually so small very few people ever see one
8. *Jewish State* In Utah where *gentile* means any non-Mormon
9 *Bull* True The bullwhip's "crack" is a small sonic boom
10. *Size* Royal, California olives come in 12 sizes the names of which were designated officially by the California General Assembly The three smallest sizes are Small, Medium, and Large From there they grow to Family-Size, Extra Large Mammoth, Giant, King Jumbo, Royal Colossal, and Supercolossal

The Centrifuge Five test tubes are balanced in the arrangement given Dillard explains Once the centrifuge is balanced you can add pairs of test tubes exactly opposite each other, and the radial balance is unchanged The tubes at 3, 7 and 11 o'clock balance the centrifuge as an equilateral triangle Two extra tubes have been added opposite each other at 12 and 6 o'clock You could add two more tubes at 4 and 10 o'clock or at 2 and 8 o'clock and thus spin seven tubes without upsetting the balance Nine tubes can be arranged so that the three empty wells are at the angles of an equilateral triangle

In other words, despite its eccentric appearances one can run the centrifuge with any number of test tubes other than 1 or 11

POTLUCK PUZZLES

1 *The Spider and the Fly* Imagine the room unfolded like a shoe box so that the different routes can be laid flat The direct



floor route A, is 42 feet The route across the floor and one sidewall B, is a bit over 40 feet. The third path C across the floor, one sidewall and the ceiling, is the shortest of all exactly 40 feet

2 *Once in a Lifetime* At that instant one could line up the first eight integers to write the time and date—12 34 5/6/78. This will not be possible again until the year 2078

3 *Spirals* Shade the spirals to show that the one on the left is a continuous loop, the one on the right is two separate loops

4 *Lucky 13* There are 13 stars above the eagle's head, 13 stripes on the shield, 13 war arrows held in the eagle's left talon, 13 leaves and 13 olives on the olive branch of peace in the eagle's right talon There are 13 steps on the pyramid and 13 letters in the motto above the pyramid *Annuit Coeptis* There are 13 letters in the motto on the ribbon in the bald eagle's beak, *E Pluribus Unum*. At the base of the pyramid, the date 1776 is written in Roman numerals, and 7 plus 6 adds up to 13

5. *Wrong Ones* Truman's middle name was simply the letter *S* Since the letter doesn't abbreviate anything, there shouldn't be a period after it *Babe* and *Meadowlark* are both given names not nicknames So they should not have quotation marks around them

6 *Put Your Money Down* By the same reasoning, I could argue that the bet is favorable to me Since a bet cannot be of advantage to both sides there must be a fallacy There is The problem is stated as if it were a pure probability question but the amount of money held by the two of us and our decisions whether or not to accept the bet are not determined by chance If I'm carrying a small amount, I'll take the bet if I have a large amount I won't. If one of us is shrewder at guessing how much the other is carrying, the odds are no longer 50-50. If we select two other people at random and run them through the bet, either person is as likely to win as to lose However the amount that would be won and the amount that would be lost in the long run would be identical.

7 *The 12 Coins* Weigh coins 1 2 3, and 4 against 5 6, 7 and 8 If the pans balance you know the odd coin is 9, 10 11, or 12 Weigh coins 9 and 10 against coins 11 and say 8 (we know from the first weighing that 8 is a good coin) If they balance, we know coin 12 the only unweighed one is the odd one The third weighing indicates whether it is heavy or light

If however, at the second weighing (above), coins 9 and 10 are heavier than 11 and 8, then you know that either (a) 9 is heavy, or (b) 10 is heavy, or (c) 11 is light To solve this "three coin problem" in one weighing compare 9 and 10 If they don't balance the heavier side is the odd coin If they do, coin 11 is light

But what if the pans don't balance on the first weighing? Suppose the side with coins 1, 2, 3 and 4 goes down It could mean that there is a heavy coin among 1, 2 3, and 4 or that there is a light coin among 5, 6, 7, and 8 To find out, set the second weighing between coins 1, 2, and 5 against 3 6, and 9 If they balance, it means that either 7 is light, or 8 is light or 4 is heavy—the three-coin problem again. Weigh 7 against 8 to determine the answer

And what if the pans don't balance on the second weighing (1 2, and 5 vs 3, 6 and 9)? Suppose the left pan goes down Then either 1 is heavy or 2 is heavy or 6 is light (we've already determined that 5 is not heavy and 3 is not light) That's the familiar three-coin problem as above, solve it by pitting 1 against 2 If instead the 3-6 9 pan is heavy either 5 is a light coin or 3 is heavy By weighing 3 against any good coin the solution is arrived at. Got it? OMNI

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Since apologies for credit omissions in our March issue **page 30,** Jon Holmberg **page 52,** Pete Turner **page 53,** Howard Sochurek **page 134,** Leonard Speier

Tens on structures **page 76,** developed and designed by Geiger Berger Associates New York

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JACKIE SKYWALKER

PEOPLE

By Dick Teresi

Jackie Parker was born on the Fourth of July 1960 and like any all-American girl, wanted as a child to become an airline stewardess. Later the times had changed and she wanted to be an airline pilot.

Today she has her pilot's license but her ambition has risen even higher. When NASA puts the space shuttle into orbit later this year, its journey will be monitored by flight controllers at the Johnson Space Center in Houston. And one of those controllers, the very youngest at age nineteen, will be Jackie Parker.

Her ultimate goal? To *fly* the shuttle.

Parker is used to being the youngest. "I entered college when I was fourteen," she told us. "That's when I decided I could do anything I put my mind to. And being an astronaut was what I wanted to do."

While in college, she applied for a job as a space shuttle astronaut and was promptly turned down. This didn't stop her. "I went to Houston on my own, a year before I graduated," she recalls, to find out what jobs were open and how to get one. A year later, after graduating at seventeen from the University of Central Florida with a degree in computer science ("Well, I was always pretty good at math"), she worked for NASA as an intern. By summer of 1978 she had a full-time job as a data processing controller.

Parker describes her present job as "Super, just super." She says she has no problems with her coworkers because of her age. And who knows? Given the delays caused by misfiring engines and tiles falling off the fuselage, Parker may end up being the *oldest* flight controller by the time the shuttle gets off the ground.

Parker: Superyouth guides the space shuttle

Scientists always complain they can't get enough money for basic research, long-term projects with no immediate payoffs. So when **George Low** dropped by our offices the other day what he had to say caught us off guard. Low, formerly manager of NASA's Apollo program and now president of Rensselaer Polytechnic Institute (RPI), believes we need more money for short-term projects with quick payoffs to entice good students back into manufacturing.

Sixty-eight percent of the wealth production in this country comes from the manufacturing industry," began the man who had the overall responsibility for placing the first astronauts on the moon. Yet today only a small fraction of our research and development effort goes into manufacturing engineering. The best people are not attracted to manufacturing-related jobs; it's not exciting to them."

So he's got this plan. Under Low's direction, RPI has founded the Center for Manufacturing Productivity. The university has drawn up a list of about 100 manufacturing problems, which will be pared down to the 10 best. Then groups of students will be assigned to each problem, each headed by a project engineer. These project engineers will *not* be faculty members, Low explains, but "a person out of school having worked in industry, say, five years. They will make the students meet schedules and keep to a budget. Things faculty members are not good at, according to Low.

Among the problems selected so far to be solved are how to use computer-controlled robots to increase production on assembly lines and how to decrease friction on bearing surfaces.

Low: Big bucks without government funding

Of course all these projects need money. The project engineers will be paid industry-competitive salaries, the students have a choice of either a paycheck or course credit. And oddly enough, Low will accept no government funding. "The ultimate customer has to be industry," he insisted. "It's got to be paid for by the person who can best supervise it. The person who can hold your feet to the fire is the guy who really needs that problem solved, and he's in industry."

So far, General Electric has taken Low up on his offer to the tune of $500 000. General Motors is kicking in $250 000.

Come next fall, RPI students can look forward to having their feet held to the fire.

Flash news item: Three Johns Hopkins scientists have *not* discovered the secret of life, but they may have figured out how it duplicates itself. **Donald S. Coffey, Drew M. Pardoll,** and **Bert Vogelstein,** of the

university's oncology center, announced recently that DNA, the master molecule of heredity, reproduces itself in a far different way than had previously been believed. If right, their discovery could lead to a deeper understanding of heredity.

For decades, scientists have assumed that DNA's double-helix structure was reproduced by enzymes that moved linearly along its twisted strands, untwining them into separate threads and then copying each to form two new double helices.

Not so, say the Johns Hopkins scientists. The trio explained that this would be far too messy a process to work inside a living cell. Coffey compared DNA in the nucleus of a cell to audio-recording tape in the reels of a cassette. Then, in front of an audience of reporters, he pulled all the tape out of an ordinary cassette and waved the jumbled mass over the podium to illustrate his point.

Then how does DNA reproduce? Using radioactive labeling in rat and mouse cells, the Hopkins scientists, working under a Bristol-Myers grant, found that the cell nucleus is indeed much like a tape recorder. In fact, it even has recording heads, called replisomes, that duplicate DNA. The DNA itself is arranged in loops, each of which is reeled through a replisome like a tape cassette and reappears as two brand-new loops.

How important is this new theory? The trio was modest, for the most part. But Vogelstein let slip that they thought this was pretty hot stuff. He compared their work to that of Copernicus. Copernicus told the world that the earth revolved around the sun, not the other way around, Vogelstein said, and they've shown that DNA moves through the replisome, rather than vice versa. But Vogelstein did note one difference. "Copernicus was tortured for his beliefs," he said. "We've been treated very well for ours."

Vogelstein, Like Copernicus but no torture

Searching for the Holy Grail
Along the Appalachian Trail,
When I found that herb
They call ginseng
Growin' deep down in the woods,
I swear I got the goods,
The herb that turns
The autumn into spring

It's a bluegrass tune, and the lead singer and composer knows whereof he speaks. When he isn't playing bass for the Howard County Dump, the band that cut the record "Ginseng" above, **James Duke** is chief of the Department of Agriculture's Economic Botany Laboratory in Beltsville, Maryland. Dr. Duke, one of the world's foremost experts on the medicinal uses of plants, has twice been featured in *Omni*, once for his work with mints and again for bringing the spiny ginseng back from China, where it's said to cure everything from impotence to cancer. Duke is less than enthusiastic about such claims for ginseng, and the result is his satirical song. Other members of the Howard County Dump also have heavy science backgrounds. Besides Duke, there's **Les Altstatt** on guitar and vocals. Altstatt, who recently retired as director of the Division of Medicine at Walter Reed Army Hospital, penned the flip side of the record, "Three Mile Island," which points out the

Altstatt: Nuclear disaster to a bluegrass beat

inevitability of human error in operating nuclear power plants—all in bluegrass style, of course. On banjo is **Rich Thomas**, a Walter Reed technician. **Bob Tate**, a Westinghouse employee, plays mandolin. While posing no threat to Bill Monroe and the Bluegrass Boys, the group nonetheless plays a listenable, rollicking kind of music (Duke calls it "redneck all the way"). The Howard County Dump performs mostly at parties, church socials, and the like. Their last gig was for a national meeting of entomologists. And, for scientists, their lyrics even get a bit racy at times. For example, the last few lines of "Ginseng":

Makes an older man more foolish
And a younger man more coolish,
Makes an older woman younger
And a younger woman hunger
Ginseng!
Sing gin
Sing a little song and swing

As they used to say on *American Bandstand*, it's got a good beat and you can dance to it. Give it an 85. ∞

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FORUM

CONTINUED FROM PAGE 12

New Wives' Tales

In your Games column (January 1980), you have number 10 of the Old Wives' Tales quiz marked as false, when it is actually true.

The question states that after eating, it's best to wait at least a half hour before going swimming. Perhaps a full stomach immersed in water does not cause cramping of the skeletal muscles. What does happen, however, is that when someone exercises vigorously right after he eats, large blood supplies that are in the stomach and intestines to aid in digestion are sent to the skeletal muscles, where the blood is needed in large supply during muscle stress. This can cause stomach cramping or vomiting. One should always rest after eating so that digestion can take place at its optimum efficiency.

Joe D. Scherer
Utica, N.Y.

John Lacarrubba, water safety specialist for the American Red Cross, replies: *If you have a couple of sandwiches and a bowl of soup and go for a recreational swim, you're in no danger of cramping, because there is enough oxygen in your system for your stomach and intestines and for the muscles used in swimming. The only way a person will get cramps is if he eats a Thanksgiving dinner and then tries to break the world's swimming record.*

I wish to say something about question 8 of the Old Wives' Tales quiz. You say that the rate of childbirth does not increase at the time of a full moon. The earliest study on the relation of the moon to childbirth was done in France and was published in *La Presse Médicale*. This study showed the birthrate nearly double normal in the two days just after the full moon. Other studies in Germany, Florida, Virginia and New York City have reported similar results.

The largest study was done by Dr. Walter Menaker, covering a half million births, and was published in the 1959 *American Journal of Obstetrics and Gynecology*. Dr. Menaker found a higher frequency of births around the time of the full moon.

The effects are strongest in areas with fewer lights, but even in New York City there was a definite lunar effect on births.

Gary Lockhart
Seattle, Wash.

George O. Abell, professor of astronomy at UCLA, coauthor of the study we cited, replies: *Carefully conducted investigations do not find correlations between lunar phase and the birthrate. Our UCLA study of 11,691 live births over a 51-month period also showed completely negative results (Abell, G., and Greenspan, B. 1979. New England Journal of Medicine, 300, 96).*

There are actually three (not one) New York studies, each of which claims to involve a half million births. The first (Menaker, W., and Menaker, A. 1959. American Journal of Obstetrics and Gynecology, 77, 905) reports a 1 percent excess of births in the two-week period following full moon; the second (Menaker, W. 1967. op. cit., 98, 1001) reports a 1 percent excess in the two-week period centered on full moon; and the third (Osley, M., et al. 1973. op. cit., 117, 413) reports a 1 percent excess in the two-week period preceding full moon. None of these contradictory reports include enough information to evaluate the selection of data and the statistical procedures. Osley and his colleagues do not even provide the dates of their study.

In my judgment, an effect so unexpected as the claimed correlation between birthrate and lunar phase can only be regarded as established after it has been repeatedly replicated by carefully controlled investigations by many independent and qualified researchers.

Ineligible Receivers

Regarding James Delson's Arts column in *Omni*'s January 1980 issue: The words of Mr. Fred Hopengarten to the contrary, his "Channel One" satellite receiving system is apparently illegal.

To quote from the January 1980 issue of the radio amateur's journal *CQ*, "... the unauthorized reception and beneficial use of addressed communications in the Multi-Point Distribution Service [is] illegal under Section 605 of the Communications Act of 1934 (as amended). Similar regulations apply in the case of unauthorized interception and use of satellite TV transmissions such as the so-called home box office (HBO) transmissions. That is, material transmitted by MDS or HBO stations is not intended to be 'broadcast' material within the meaning of Section 605, and so authority for its reception and use must be given by the sender."

To use a "Channel One" type system legally, you merely need to procure a home satellite television earth terminal license from the FCC. It costs nothing, and the forms are relatively easy to complete.

One more thing: As for the $15,000 price tag on Mr. Hopengarten's "Channel One" system, you can get by much more cheaply if there is an MDS station in your area. These are over-the-air relay systems for cable TV (including HBO) programming, and their reception packages cost about $60. These are not, however, off-the-shelf items, and their use so far has been limited to technically oriented types (like hams) who have the know-how to construct a 2.15 GHz receiving system "converter." Most MDS company operators will authorize you to receive their transmissions with your own home-built receiving equipment if you will agree to pay the monthly service charge like any other viewer. Actually, the law is almost unenforceable, but it's best to make it legal, just to be safe.

Wayne Ditsworth
Cedar Rapids, Iowa

EXPLORATIONS

By David Saltman

Magic shows are just like life only fairer in life you don't know you've been fooled until it's already too late.

Since the days when sorcerers cast spells on entire kingdoms, magic has never failed to baffle and to intrigue. The ancient prestidigitatory art is the only certain "body of miracles" that every person on Earth has witnessed. Fortunately, it's booming today with some 50,000 magicians practicing conjuring in the United States alone.

Don't settle for the third-rate jokes of pranksters. Take a magician's tour of the United States. Visit the places where magic is practiced, and be genuinely fooled. Amateurs, professionals, or simply magic lovers are all welcome everywhere in the charming world of illusionists.

Times Square in New York City is unquestionably the hub of America's magical activity. Not only the hotchkid in the big city ends up in Times Square, but the one-way wizard, too. Many of these Merlins congregate at the Gaiety Restaurant, 224 West Forty-seventh Street, site of the Magic Table, one of the most venerable, yet most illusive, of New York's *misterioso* attractions.

To the uninitiated, the restaurant seems to be nothing more than a nondescript Broadway eatery. Yet — Shazam! — every day magicians and fans of magic materialize there for lunch. Be prepared to cut open a melon and find a three of spades inside. Of course, the three of spades has your initials on it and appears to be the very same one you chose and signed a few minutes before, upon sitting down. Amazed, you ask for the sugar, and — a live dove materializes in your hand. Ask for the menu — if you dare!

AT THE MAGIC SHOP

New York is not magic's sole home. Along the faded tracks of vaudeville you'll find many shops and clubs catering to magicians. After all, if you were playing the old Gus Sun circuit, you never knew when you might need an emergency supply of flash powder, red silk scarves, or multiplying billiard balls.

There is probably a thriving magic dealer in your town or nearby. If your neighborhood sports a magnificent old theater converted from vaudeville to Disney to porno, you should find an aging nostrum seller not far away.

Ed Seguin — the Mysterious Marvelous in Akron, Ohio. He'll be able to tell you the lore of bygone times when there were two shows a day and "magicians wore scarlet, damson and verdigris, their hoods and cloaks and smiles asnap with wizardry (Magicians' wives wore brown and were very hard to see. . . .)"

Magic shops vary in atmosphere from Snyder's in Cleveland, to the Wizard, in Boulder, Colorado, to Lou Tannen's, back in New York. Snyder's is a dusty meander through the attics of vaudeville. The Wizard represents the modern magic dealer: slick, colorful, well packaged, with every hair in place on the ventriloquist's dummies. Tannen's boasts of being the world's largest magic shop (see box).

Every Saturday afternoon, by tradition, all the wonder-workers in every town wander down to the local magic shop as if drawn by a black silk thread. There they show off new tricks and dust off old ones. Stopping by is one of the pleasantest ways to become initiated in the art of chicanery.

AN EVENING AT THE MAGIC CASTLE

The spirit of shamanism still lives in Hollywood, California. A drive into the hills will take you to a remarkable temple of thaumaturgy called the **Magic Castle**.

Entering the Castle is like walking through the looking glass. You must sidle up to an owl on a bookshelf in the lobby, wink your left eye very slowly, and pronounce the incantation "Open, Sesame!" A section of the bookcase swings aside to let you enter the bar.

There you encounter a piano without a pianist that plays any tune on request. You can peruse a small magic museum crammed with old-time gear: stage guillotines, "Water from Persia," mechanical chess players, and other

marvels. Booby traps lurk everywhere, from the men's room to the bar.

If you're lucky, you may get to see the incredible Shimada, reigning Crown Prince of magic, in the Castle's auditorium. His act is silent and uses choreographed moves from the Japanese martial arts. The stage starts bare, then, presto! A black sleeved arm plunges from behind the back curtain and produces a flaming torch out of thin air! Shimada inches out like a snake, the torch in his hand. Dressed in faultless evening clothes, he looks like a Buddha at a debutante ball. Suddenly Shimada stretches into the air, and a second flaming torch appears from nowhere. He continues to produce them until the whole stage is illuminated by dozens of flaming torches with the shining Shimada at the center.

THE SECRET OF DR. VOX

A magician needs just one trick, as a recent incident at the Wizard magic shop shows.

It was the day of Pearl Street's annual outdoor magic show, a gala event in this small town at the foot of the Rockies. As I approached, a crowd peered up at a man, locked Houdini-like in a straitjacket, suspended upside down from a crane 30 meters in the air.

But my thoughts were not on magic. They were on a distant cousin of magic: gambling. I was trying to hustle up a card game for the simple reason that I was broke.

So I was happy to bump into Sam Kent, proprietor of the Wizard. Magicians usually know where the card games are, though they seldom play. (If they win, everyone thinks they cheated; if they lose, everyone thinks they're lousy magicians.)

As we strolled back to Sam's shop, with me steering the conversation to three-card monte, a kid came up to us.

"Are you guys magicians?" he asked.

"Sure," we answered.

"Okay," he said. "Read my mind."

This is the sort of challenge magicians hate. But empty pockets are sometimes more powerful than whiffle dust.

"You have any money, kid?" I asked.

"I've got five dollars."

"Okay. I'll read your mind for five bucks."

He looked hesitant.

"Look, kid," I said to him. "We've never met before, isn't that right?"

"Right."

"So if I could tell you your name, wouldn't you consider that a feat of mind reading worth five dollars?" I'd need at least $5 to buy chips.

"Well, yeah." He looked suspiciously at himself to make sure he didn't have some kind of name tag sticking out of his socks or somewhere else. He didn't.

"Okay. Come inside." We entered the magic shop.

Quite frankly, I had no idea how I would read the kid's mind. But inspiration, or perhaps desperation, led to a plan.

I turned to Sam and asked, "Got any Ouija boards?"

Magicians rarely use them, but Sam stocked one for the pseudo-occult crowd. I had played around with Ouija boards but did not know whether what I had in mind would work.

We assumed the position: seated, knees touching, fingers lightly on the sliding dingus with the plastic window.

"Now I want you to concentrate on your name," I said to the kid. He screwed up his eyes. "Are you concentrating?" I asked.

"Yes," he answered.

"On *your* name," I insisted. "Don't try to fool me by thinking of someone else's."

We sat a moment. Then the dingus began to move. It circled the board clockwise three times, hovered, and nearly stopped at the *S*. It began to circle again. I can tell you for sure, I wasn't moving it. It stopped on the *T*, it began to circle again, and this time it stopped on the *E*.

"Steven! Your name is Steven," I said to the startled kid.

"Th-that's right," he admitted. The crowd of kibitzers had grown quite substantial by then. The spectators cheered, and Kent came up and threw his arms around me.

"Saltin'," he said, "let's make us some money with that trick of yours." He outlined the following madcap plan: I was to give myself out as Dr. Victor Vox, the infamous wonder worker who had developed—after rigorous practice with Tibetan lamas and various other sorcerers—a genuine, no-hokum "touch of larceny" that could locate any object of value, no matter where it was hidden.

Using old magic posters and press type we whipped up hundreds of handbills and enveigled the kids hanging around the shop to pass them out. By that night, bills bally-hooing "Dr. Vox and the Wizard" were an eyesore in Boulder.

The show was set for the next day at the shop. We were successful beyond our dreams. Kent performed splendidly in his part, appearing unhurt when "hypnotized" and pricked with magical "needles." He also managed to give the illusion of quaffing vials of steaming acid. But the greatest hit of all was, to my surprise, "The Secret of Dr. Vox."

It was a simple adaptation of the Ouija board scam to the theater. When I left the shop, a spectator would come up and hide an object—a coin, a bracelet, a watch, whatever—somewhere on the stage. When the object was well hidden, I, Dr. Vox, would return and hold the spectator's wrists lightly, asking her (it was usually a woman) to concentrate on the place where she had hidden the trinket. Invariably within about 30 seconds I would feel the woman's wrists tugging me in a definite direction. I simply followed.

Like the dingus going in circles, we would usually perambulate the stage until, after a minute or so, I would feel a definite pull in the direction of one quadrant or another. To the audience, it appeared as if I

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— P. de lancre (1622)

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zeroed in on that part of the stage, and since I was usually 'getting warm,' the tug would be confirmed by an intake of breath that was as loud as a thunderclap to a magician with holes in his pockets and a reputation at stake.

In another 30 seconds or so as we walked around the indicated quadrant, I would get another tug. Stopping dead in my tracks, I would turn to the nearest cup or candlestick and lift it in the air. *Voilà!* There would be the bracelet.

Really this is only a half-trick. I believe it works on the principle that the subconscious always influences the so-called fine muscles. Even when one tries mightily *not* to think of elephants, one's fine muscles strain in the direction of Africa. This phenomenon has never been studied by behaviorial scientists; in fact it was never even dreamed of. It's proof of the existence of an underlying psyche because even if the subject tries to mislead you, his muscles will still give that involuntary tug.

Clearly, there is a part of us that wants the wizard to win. And there lies the real magic. The subconscious mind inevitably tricks our cunning rational self into revealing its true motives. As proof of that Kent, the kids, and I, Dr. Vox all made out very handsomely. We received an impressive number of perfumed notes delivered backstage.

PLACES WHERE MAGIC DWELLS

Chicago: Magic, Inc., 5082 North Lincoln. A dealer of hot tricks.

Dallas: It's Magic, 5417 Greenville Avenue. A club on Restaurant Row. Stage and quality performers in an intimate setting.

San Francisco: Earthquake McGoon's Magic Cellar, Clay and Montgomery streets. Performers of varying skill, some outstanding, like Arthur Murata, the "house" conjurer. Great decor.

New York: Lou Tannen's, 1540 Broadway. The world's largest magic shop.

Cleveland: Snyder's, 216 West Superior. A relic of vaudeville days.

Akron, Ohio: Ed Seguin, 4153 Meadow Lark Trail. Old time tricks and routines.

Las Vegas: Caesars Palace, Bacchanal Room. The legendary Jimmy Grippo, magician in residence.

Washington, D.C.: Al's Magic Shop, 1115 H Street, N.W. The only tricks in Washington that are not dirty.

Winston-Salem, North Carolina: NBK Distributors, 1240 Churton Street. Fast-growing, modern magic shop and jobber.

Minneapolis: Eagle Magic Store, 708 Portland Avenue. Old fashioned, low-key.

Hollywood, California: The Magic Castle, 7011 Franklin Avenue. Though this club is private, many Angelenos belong and will provide you with a guest card. *The Magic Corner*, 6338 Hollywood Boulevard. Excellent magic shop.

Colon, Michigan: Colon Magic Festival, sponsored by Abbott's Magic Shop. Held every year, the third week in August.

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CONTINUED FROM PAGE 10

will pass near Earth every several thousand years.

Such a system would allow for body integrity through the eons with the possibility of future retrieval and revival—a slight chance exists of possible revival by another intelligent race in a distant star system—remote but a possibility definitely worth considering.

Chester Twarog
Aurora, Colo.

Slight Miscalculation

Your article "Infinite Voyager" [February 1980] by F. C. Durant II properly emphasizes the meticulous care Chesley Bonestell has taken in his imaginative renderings of our universe. Knowing Mr. Bonestell's reputation, I must conclude that the error on page 72 is yours. Your caption for the painting *The Milky Way* states that it is a view of our galaxy from a distance of 250,000 miles. Hardly. Two hundred fifty thousand light-years would be a better guess.

Nonetheless, a fine sampling of Mr. Bonestell's work.

Rod Ajusra
Gaithersburg, Md.

Our apologies. We were, of course, in error. The distance should have read 250,000 light years. —Ed.

The Life of John

I just read "The Life of Arnie" [January 1980]. Thanks, Mr. Stine. You've described the future just the way I always hoped and dreamed it would and should be.

John Fitzgibbon
Miami, Fla.

Dear Ben

As an old friend and reader of yours, I approve of your views of the world and I like the way you write.

Nevertheless, I was not prepared for the utter joy and excitement with which I read your editorial in the February 1980 *Omni*.

It was well written and well thought out, yes, but its elegance and sense had me cheering as I read.

And also biting my lips. How I would love to have written that essay myself if I had only been smart enough to think of it first!

Isaac Asimov
New York, N.Y.

Canadian Cow Flap

After reading Harry Lebelson's article "Death on the Range" [UFO Update, January 1980], I hope more light will be cast on these unexplainable cattle mutilations. One point Mr. Lebelson overlooked was that these mutilations were not confined to the United States. They have also occurred in increasing numbers in Alberta, Canada.

Rod Faust
Cranbrook, B.C., Canada

X MARKS THE UNIVERSE

STARS

By Mark R. Chartrand III

On November 8, 1895, Wilhelm Conrad Roentgen could hardly have known that the mysterious "X rays" he had just discovered would be used to detect heart ailments, to find flaws in precision metal castings, and to uncover art forgeries. He and the astronomers of the day (if they paid any attention at all) certainly would not have suspected that these rays would plumb the depths of the universe.

It took a while because, as far as X rays are concerned, we've been under the equivalent of a meter-thick lead shield. That shield is the atmosphere, which stops X rays from penetrating to Earth's surface.

Then in 1949 a rocket-borne x-ray detector, more like a Geiger counter than a camera, found X rays coming from the sun. The era of x-ray astronomy had begun.

There is an element of serendipity in every science, and this new offshoot is no exception. A rocket flight in 1956, sent out to investigate solar flares, picked up a strange phenomenon — a general x-ray background coming from all over the sky. The mystery intensified when another rocket flight in 1962 revealed that these rays emanated from the center of the Milky Way. The old stars thought to be the inhabitants of galactic centers should not emit enough X rays for us to detect them over a distance of 30,000 light-years. What makes stars that we think we understand radiate so much?

By 1966 some three dozen x-ray sources had been identified. The search continued with rocket probes and high-altitude balloons. But the heyday of x-ray astronomy came with the satellites and orbiting observatories that followed.

In a meeting last January of the high-energy astrophysics division of the American Astronomical Society, six dozen research papers reviewed the turbulent, exciting, and still puzzling field. Most of the results reported came from experiments aboard such satellites as Small Astronomy Satellite 3 (*Uhuru*), and the High Energy Astrophysical Observatories 1 and 2.

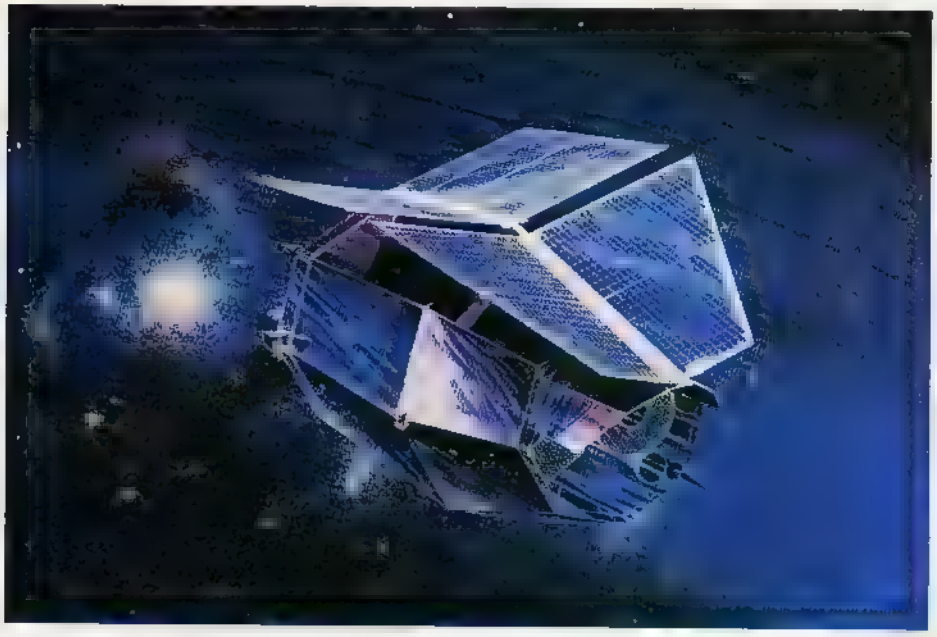
HEAO-2, dubbed *Einstein*, was launched in 1979, the centennial year of Einstein's birth. This telescope is destined to have as profound an impact on astronomy as the man himself, for it can make images of x-ray sources while locating and measuring their intensities. For the first time astronomers can examine photographs by using television. This has revolutionized the field and produced what one researcher called a grab bag of sources. Aim the telescope in any direction, and you're bound to find a new x-ray emitter. Or if you prefer a more refined approach, study the sky where previous, less sensitive telescopes found nothing.

The X rays used by doctors are typically known as "hard" X rays. The energy of each particle, or photon, of radiation is quite low, ranging from tens to several thousands of electron volts. Astronomers use these and less energetic "soft" X rays to peer at the cosmos. Because of the high energy of all X rays, it's hard to focus them so that they will form an image. There are no x-ray lenses to refract the energy, and only when they encounter mirrors at very shallow grazing angles will they reflect. Such are the difficulties, and rewards, of building a satellite like *Einstein*.

There are now more observations than theories to explain them. X-ray sources such as the sun, remnants of supernovas and quasars are scarcely surprising to scientists. There is still some mystery about the X rays that emanate from other galaxies, intense briefly emitting sources at the hearts of globular clusters of stars, x-ray stars in the nearest spiral galaxy that do not lie along the spiral arms so prominently seen in visible light; and a pervasive glow of X rays from hot gas throughout the universe.

In all likelihood the most interesting results will come from the more general investigations. The title of one of the papers presented last January gives a hint of how far advanced this branch of science is. "An Optical Identification Program for Serendipitous Einstein X-Ray Sources," by astronomers from Columbia University and UCLA.

X-ray astronomy may be the most interesting channel to watch in the coming decade. Stay tuned. ∞



HEAO-2, the Einstein orbital observatory, has revealed a startling variety of x-ray sources.

Omni presents, for the first time anywhere, an exclusive photograph of the flight deck of the space shuttle *Columbia*, now being readied for lift-off at Cape Canaveral, Florida. The commander of the ship sits to the left, the pilot to the right. Between them is the flight computer and navigation console, and in front of them are airspeed indicators, altimeters, and the like. Several computers combine data derived from flight instrumentation and hand control units—located directly in front of the seats—for quick visual display on three cathode-ray tubes. Finally, environmental and lighting controls are overhead, along with additional electrical instrumentation. Klaus Wilckens, of Technicolor Graphic Systems, took this photograph for NASA, using a Nikon F camera with a fisheye lens and Kodak Vericolor Type S film.

The heart of a rose, strange facts, and potluck puzzles

GAMES

By Scot Morris

"It's more fun to arrive at a conclusion than to justify it."
—Malcolm Forbes, *The Sayings of Chairman Malcolm* (Harper & Row)

That sentiment echoes our thoughts. It's the frolic in playing, not the logistics, that makes games worthwhile. Knowing that all the readers who follow this column are in it for fun, this month we present some playful pastimes.

Our first offering is an induction game called Petals Around the Rose. It is played with five dice. One person rolls the dice, looks at the outcome, and then announces a number. The thrower is Potentate of the Rose and knows the secret. Others try to determine the formula by which the Potentate derives his number.

The name of the game is significant. The announced number is always even and is indeed a true function of the five faces.

1. (10)

2. (2)

3. (6)

4. (8)

Those who are in on the secret easily agree on the number that applies to each throw. For every set of faces there is only one number, though different sets of faces may at times have the same number.

Petals Around the Rose was called to our attention by Martin Gardner. The game first made its appearance about four years ago in computer circles and has become increasingly popular with the general puzzler. It is most fun when played in a group with one person who knows the secret and several others guessing what the numerical answer might be. We can only approximate that here. We have reproduced a series of 12 throws, with the correct responses (in parentheses) that

5. (12)

6. (2)

7. (0)

8. (14)

9. (10)

10. (16)

11. (6)

12. (2)

the Potentate of the Rose should give for each. Can you figure out what simple system is used to come up with each answer?

STRANGE FACTS

The following items are excerpted from my Doubleday/Dolphin paperback *The Book of Strange Facts and Useless Information* (1979):

1. MAGIC STUFF. It can help clear up your acne, clean your teeth, soften your beard, deodorize your body and your refrigerator, calm your upset stomach, fireproof your Christmas tree, cure your cattle of the bloat, and make your chickens produce eggs with yellower yolks. If a woman douches with it after intercourse, it encourages the production of a male baby. What is this magic substance?
2. FRENCH SPREAD. It was invented in France in 1863 and was the first artificial food ever created. It initially consisted of beef suet, warm milk, and sheep-stomach lining. What is it?
3. RARE TREAT. It is the most nutritious food of any kind. It is richer in vitamins than meat. It is easy to prepare and is available all over the world, yet few people use it. You cannot order it in a restaurant or buy it in a health-food store. What is it?
4. LIGHT FANTASTIC. Its light production has been called the most efficient form known to man. It gives the coldest light of any in the world. Only about 1 percent of its energy is lost as heat. What is it?
5. MOVING EASY. It is the most efficient kind of motion known to science, surpassing all moving machines (from jet planes to sports cars and rowboats) and all animals (from cheetahs to eagles and trout). In transporting a quantity of weight across a given distance, this form of movement uses less energy than any other. What is it?
6. HOT OR COLD. When is the sun closer to the earth—in June or December?
7. COMMONPLACE. Which is more common, an eclipse of the sun or an eclipse of the moon?
8. JEWISH STATE. Where is a Jew a gentile?
9. BULL. A hyperbolic matador once said that the tip of a bullwhip travels so fast it breaks the sound barrier. True or false?
10. SIZE. Which olive is largest—Large, Royal, King, Jumbo, or Mammoth?

Here's a curiosity of mathematics. It is said that many years ago Ethiopian peasants could not understand multiplication. They could, however, halve and double numbers with counting pebbles (dividing a number of pebbles into two equal parts to find half of the number, duplicating a pile of pebbles to double the number). From this primitive beginning they developed an ingenious "multiplication system," which baffles most Western mathematicians.

Suppose a merchant wanted to buy 15 goats at, say, $13 apiece. We could calculate the price he'd pay by simple multiplication ($195), but to see how the Ethiopian would find it, set the numbers *13* and *15* in two columns, labeled *Half* and *Double*. Either number can go in either column, but for the sake of this illustration set them up like this:

HALF	DOUBLE
13	*15*

Now halve the *13* to get 6½. Ignore the ½; Ethiopians don't understand fractions. Then double the *15*.

Continue halving and doubling pairs of numbers, discarding all fractions, until the *Half* column reaches 1:

HALF	DOUBLE
13	*15*
~~6½~~	*30*
3	*60*
~~1½~~	*120*

At this point, legend says, Ethiopians invoked an ancient superstition. They considered that any pair of numbers with an even number in the *Half* column was evil and had to be destroyed. In this example, scratch out the 6 and the 30.

Finally, add the remaining numbers in the *Double* column and there's your answer:

HALF	DOUBLE
13	*15*
~~6~~	~~30~~
3	*60*
1	*120*
	195

It works!

Try the system with any pair of numbers, large or small. It always works. Mathematicians say that if we were more familiar with the binary number system we would find the procedure intuitively obvious. But most of us, accustomed to thinking in decimal numbers, find Ethiopian pebble multiplication almost incomprehensible, a curious set of haphazard rules that somehow, more by magic than math, invariably leads to the correct answer.

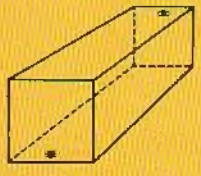
READER ORIGINAL: $25

THE CENTRIFUGE. L. A. Dillard, of Temple, Texas, writes: "I work in a laboratory and have a puzzle concerning a common piece of lab equipment, the 12-place centrifuge. It contains 12 wells in which test tubes may be placed and spun rapidly. The centrifuge will run smoothly only if the tubes are balanced. How many different numbers of equal-weight test tubes may we spin at once and have a balanced centrifuge?"

Dillard eliminates the easy answers first: One cannot spin just one tube alone without setting the centrifuge off balance; nor can one balance 11 tubes, for the vacant space will throw the machine out of kilter. It is just as obvious that any even number of tubes can be arranged to balance out, by placing them in the centrifuge by pairs.

What if there are three, five, seven, or nine test tubes? Three can be handled easily by placing them at the 12, 4, and 8 o'clock positions (above, at left). Are the other numbers possible? At right, for example, is a possible arrangement of five test tubes. Will it make the centrifuge spin smoothly or make it wobble?

POTLUCK PUZZLES



1. THE SPIDER AND THE FLY. This puzzle, concocted by Henry Ernest Dudeny, involves a closed, 12 × 30-foot room that has a 12-foot-high ceiling. In the middle of one end wall, a foot above the floor, is a spider. The spider wants to eat the fly caught in its web in the middle of the opposite end wall, one foot below the ceiling. What is the shortest path the spider can take to reach the fly?
2. ONCE IN A LIFETIME. Something very unusual happened on May 6, 1978, at 12:34. What was it?
3. SPIRALS. What is the difference between these two designs?

4. LUCKY 13. Look at the green side of a dollar bill, on which are reproduced the two faces of the Great Seal of the United States. The number *13* is represented in at least nine ways on this side of the bill. Find five of them.
5. WRONG ONES. What is wrong with the following names?

   Harry S. Truman
   "Meadowlark" Lemon
   "Babe" Didrikson Zaharias

6. PUT YOUR MONEY DOWN. Here's the bet: I'll bet you all the money in my pocket at this moment that I have less money than you have in your pocket.

Should you take the bet? Consider: Either of us could be carrying any conceivable amount of money so that in the long run the chances of winning this bet are 50-50. But consider also that the amount of money you stand to win is greater than the amount of money you stand to lose. In the long run, this wager seems to be in your favor. What can you say about such reasoning?

7. THE 12 COINS. You have 12 coins. *One* is counterfeit and is *either* heavier or lighter than a genuine coin. With a two-pan balance scale, how can you find the odd coin and determine whether it is heavier or lighter, in just *three* weighings? This weighing problem is a sure cure for a sound night's sleep. ∞

Answers: page 128.

SCIENCE-FICTION SURVIVAL KIT

LAST WORD

By Ben Bova

It struck me, as I sat watching the movie *Alien*, that readers of science fiction are much better prepared to face extra-terrestrial emergencies than movie people are.

Here was a shipload of officers and crew, scared to death because they had set aside the rules and had brought a voraciously carnivorous, thoroughly nasty alien creature aboard their vessel, and they didn't know how to get rid of it.

"Jump into your spacesuits and open all the hatches!" the science-fiction readers among the audience shouted.

The actors playing the idiotic crew of the doomed ship *Nostromo* ignored that advice. Until the very end of the film, of course, when the last remaining member of the crew donned her spacesuit, opened all the hatches, and blew the alien into the final credits.

Okay. So they had to give the audience a couple of hours of chills and frights for their price of admission. But most science-fiction readers lost interest in the film very early, simply because they knew how to handle the alien and because the crew of the ship obviously didn't.

This set me to thinking. There are lots of things that science-fiction aficionados know so well that they take the knowledge for granted, and they assume that everyone else knows these things, too.

Not so.

For instance, consider the problem of First Contact. You're in a spacecraft, way out there among the stars, and you meet the spaceship of an alien race. You exchange pleasantries with them. After all, it's not every day that you make contact with an intelligent extraterrestrial species.

But you don't tell them where your home world is!

The aliens may seem kindly disposed, but how much do you really know about them? Perhaps they're aggressive, carnivorous, sex-starved. Anything is possible. You certainly don't want to invite them to Earth until you are absolutely certain they won't wipe out mankind or enslave us, use us for pet food, or steal all our wimminfolk. As H. G. Wells once put it, when a highly superior extraterrestrial race tells us that they want only "to serve mankind," we should inquire whether they wish to serve us baked or fried.

Yet what have Carl Sagan and the astronomers done? On each *Voyager* and *Pioneer* probe that's been hurled out beyond the solar system they have put *maps* aboard that tell any alien with eyestalks *exactly* where Earth is!

Just because it may take a million or more years for these Judas-goat spacecraft to reach another star system is no reason for us to feel safe or complacent. We do care about our descendants' welfare, don't we?

There are all kinds of survival facts known to readers of science fiction that the average person has never even thought about.

No matter where you travel, you really don't have much to fear from alien germs. Persons who don't read science fiction worry about contracting some alien disease only slightly less than about being gobbled up by an enormous alien carnivore. Neither threat is much of a possibility, in actuality.

Alien critters—microscopic or mastodon-sized—are *alien*. Their biochemistry is not our biochemistry. Earthly viruses and bacteria make us ill because they are adapted to our biochemistry and can live parasitically upon us.

Alien microbes can't. And won't. Sure, NASA put the Apollo astronauts into quarantine on a "better safe than sorry" policy. And Michael Crichton got rich and famous by scaring millions of people with *The Andromeda Strain*. But science-fiction readers were bored with both NASA and Crichton. We could have saved a lot of money there, if the rest of you had listened to us.

However, human biochemistry is probably poisonous to alien creatures. And vice versa. If you ever visit extraterrestrial resorts, don't drink the water! If an alien carnivore takes a bite out of you, it may be unpleasant for you, but it might prove fatal to the alien. The chemicals that make us strong and healthy may very well be poisonous to an extraterrestrial. (Another strike against the film *Alien*.)

There are seemingly endless implications here for extraterrestrial sex, but these are clearly without issue.

Further survival hints known to science-fiction aficionados:

You will never die of loneliness in space. No matter where you are marooned, all sorts of "people" and/or things will drop in for visits. Just read the literature. Even Robinson Crusoe had his hands full before too many chapters had gone by.

Perhaps the most important piece of survival knowledge that is familiar to science-fiction readers and few others is this: In most movies, scientists are portrayed as having the intelligence and moral scruples of movie producers. (That is, virtually none of either quality.) This is not true in real life. Scientists are about as intelligent and morally straight as, say, science-fiction authors.

Therefore, we have very little to fear from scientists. They are really fine people, for the most part. But we do have rather a lot to fear from movie producers.